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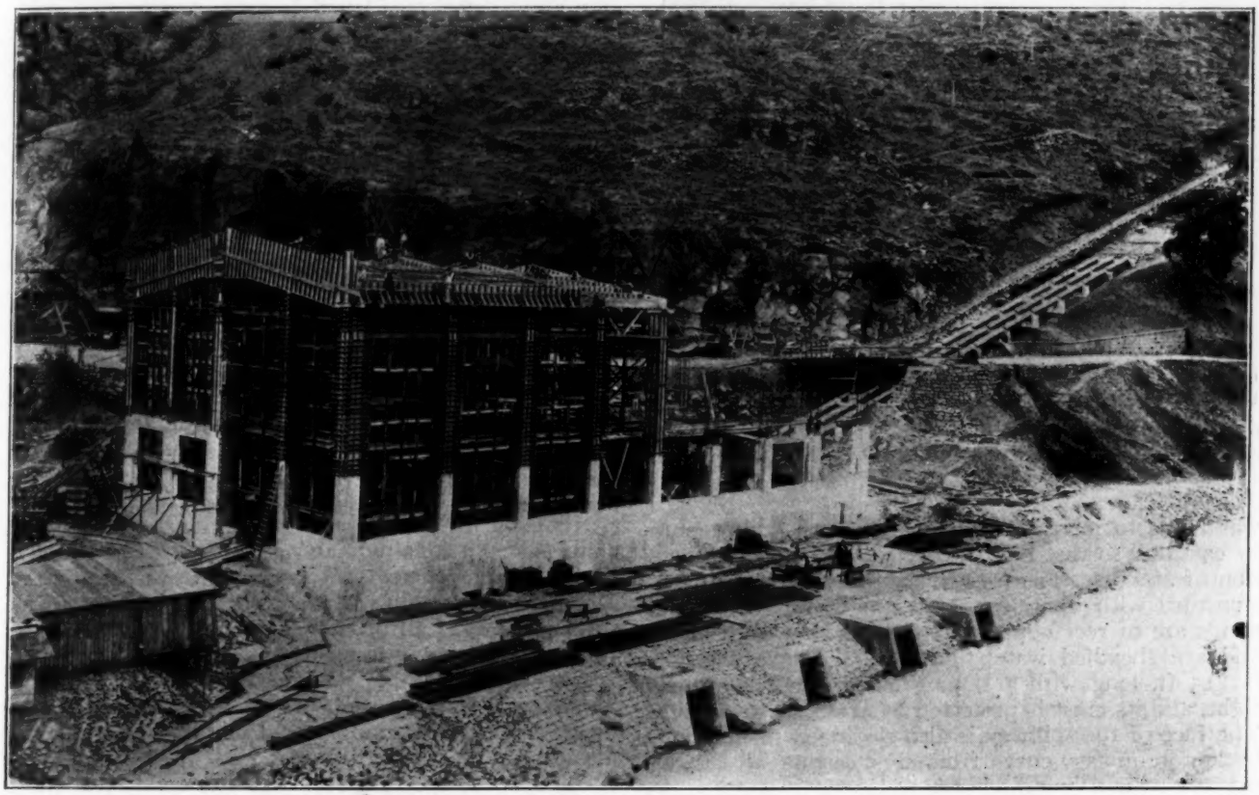


Pangal Power House of Braden Copper Company While in Course of Construction.

New Hydroelectric Power Plant at Rio Pangal, Chile

Construction Features of Diversion Dam, Seven-Mile Pipe Line, Penstocks and Waterwheels for New Plant Built by the Braden Copper Co. to Supply Power to Its Works at Sewell, Chile

By HUGH L. COOPER

FOR the purpose of supplying additional power to its works at Sewell, Chile, the Braden Copper Co. is building a new hydroelectric plant, which is a development of Rio Pangal for power purposes. This stream, which is a tributary of Rio Cachapoal, has its headwaters in the high mountainous regions along the Argentine boundary, and its course is westward through a deep and precipitous valley to its junction with the Cachapoal, 20 miles east of Rancagua.

The waters of the stream will be impounded by a diversion dam at a point about 10 miles up the river. Water will be conducted from the diversion dam by a combination wood-stave and riveted-steel feeder pipe about 7 miles long, located along the north side of the canyon, to a surge tank. From the latter point it will be conducted down the mountain side in a straight line to the power house, by means of a welded-steel pipe penstock about 4000 ft. long.

Above the diversion dam is a drainage area of about 220 square miles, which is in precipitous mountain slopes, practically devoid of vegetation and subject to torrential storms. The estimated quantity of water available for power purposes has been based upon continuous records of runoff kept by the company for several years. A comparatively large quantity of stored water will be secured by means of the

diversion dam. A large storage reservoir site has been located further up stream, which may be utilized to augment the natural stream flow. The plant has been designed to utilize 220 cu. ft. of water per sec.

Diversion Dam and Head Works.

The diversion dam was first built to its low level with its crest at an elevation of 4610 ft. Provision

Pangal Hydroelectric Development—One of the Riveted Steel Sections of the Pipe Line Which Were Installed on All Curves of Less Than 375-Ft. Radius.

was made to increase its height at some future time by earth fill so that the pond level will be at an elevation of 4680 ft. The present dam is a framed timber structure with abutments and spillway. The abutments are of rectangular crib construction, rock filled, and are sheathed water-tight. The spillway section is 215 ft. long with a sloping back, sheathed water-tight, and its crest is protected by armored steel plate. The face of the spillway is also sloping, with the lines broken in an easy curve from crest to toe—all for the purpose of carrying discharge water safely away from the foundations of the dam. The entire structure is founded upon a deposit of compacted gravel, with some sand and boulders. This accounts for the extreme width of its base and the care used in providing suitable bearing for the bed timbers. The heel of the dam and the abutments are connected and sealed to a continuous concrete cutoff or core wall, which fills a trench excavated to bed rock or to a stratum which is considered impervious.

In addition to the dam, the head works comprise an intake tower, located 100 ft. upstream from the core wall of the dam, and a feeder-sluice conduit, extending from the intake tower through the dam to a point 500 ft. downstream. Concrete was used in the construction of the intake tower, which is octagonal in plan, with an operating deck on top connected to the dam abutment by a front bridge.

The central circular well is the beginning of the main feeder pipe supplying water to the power house by connection through the feeder-sluice conduit. Water is admitted to the well by seven radial ports, which are simultaneously controlled by a large cylindrical valve in the well. Each port is provided with a removable steel screen and a timber gate or stop log for emergency use. At the bottom of the tower and near its outer circumference are seven circular sluice openings, each controlled by a cylindrical valve. These holes open downward and merge into the lower opening of the feeder-sluice conduit. The purpose of these openings and valves is to remove deposits of sand, silt, etc., from the immediate vicinity of the tower, by sluicing from time to time, and thus prevent their entry into the feeder. The entire tower, including the sluice valve, may be closed by the outside stop logs provided. All valves, screens, stop logs, etc., are operated by a crane at the top of the tower.

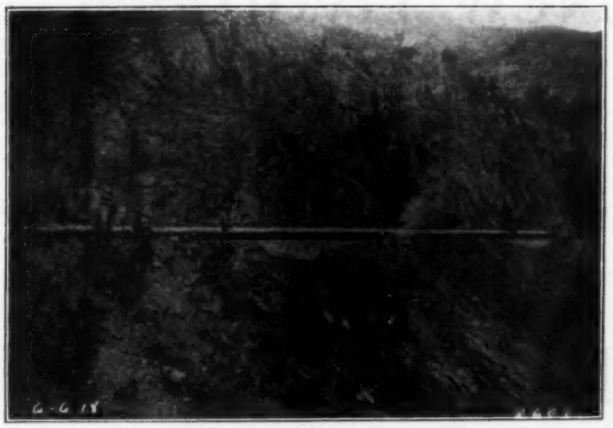
Concrete with steel reinforcements was used for the feeder-sluice conduit, which has an upper opening 80 ins. in diameter, which is an extension of the feeder pipes, and a lower opening 54 ins. in diameter from the sluice valves for discharge into the river. The two openings, or pipes, are conected by a cross-over valve near the end of the conduit. This valve is so constructed that in case of accident or necessity for repair to the main control valve in the intake tower, backwater may be excluded from the well and water for power purposes supplied by the sluice valves, thus contributing to uninterrupted service.

Construction of the Feeder Pipe.

The feeder pipe is 80 ins. inside diameter and 36,723 ft. long from the dam core wall to the surge tank. The center line is at an elevation of 4590 ft. at the intake tower, from which it slopes uniformly downward 15 ft. per mile along its developed length to an elevation of 4485.67 ft. at the surge tank. In plan it follows a winding course along the tortuous side of the canyon. All bends of less than 375-ft. radius are of riveted-steel pipe, built from 3/8-in. plates in 6-ft. inside and outside cylindrical rings alternately, with single-riveted transverse joints and double-riveted longitudinal lap joints.

Standard wood-stave construction is used for the remainder of the pipe, which is its principal part. The staves are of California redwood, finished true to form all over, 48 in number, 3½ ins. thick and of an average length of 14 ft. When delivered, the redwood lumber was rough sawed. It was finished at the site by special wood-working machinery installed for this purpose by the Braden Copper Co.

The bands are of 7/8-in. diameter mild steel rods, in two parts around the circle, with standard malleable iron shoes at the connections. The band spacing varies, according to pressure, from 26 to 54 per 10-ft.



Pangal Hydroelectric Development—Showing Some of the Difficulties Met in Construction of Pipe Line.

length of pipe. The pipe terminates in an expansion joint and cast-iron tee connection to the surge tank.

Framed timber saddles, spaced 6 ft. apart, are used to support the entire feeder pipe line. Manholes are provided at intervals of 500 ft. and drain valves with piping are fitted near the surge tank.

Preparation of foundation along the mountain sides was a difficult undertaking because of the great

length of pipe, inaccessibility and the varying conditions and nature of materials encountered. This work involved many timber bridges, masonry culverts and retaining walls, tunnels and other special construction.

Surge Tank.

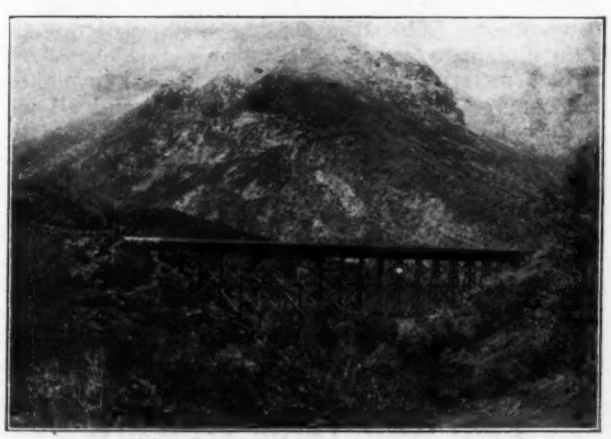
The surge tank is of the differential type, selected because of its economy and effective control of sudden fluctuations in flow. It is built of steel throughout. The outside shell is 16 ft. inside diameter and 129 ft. high, with base at elevation 4525, thus providing for a maximum surge of 34 ft. above the pond surface. The inner tube is 64 ins. outside diameter.

To insure stability and true form because of the great height and small diameter, the inner and outer shells are connected and braced from top to bottom by four lines of radial trussing in vertical planes. The feeder pipe approaching the surge tank and its extension from surge tank to penstock is placed in a tunnel through a spur of the mountain. This was done for the purpose of removing the surge tank back from the sloping surface and so reliable rock foundations could be secured.

Penstocks.

In plan, the penstocks are in a straight line from the end of the feeder pipe to the power house, a distance of 4000 ft. They are connected to the feeder pipe by an expansion joint and Y-lateral, for its upper portion (about one-third) consists of two pipes of 46 ins. inside diameter. Each of the 46-in. pipes branches into two pipes of 30-in. inside diameter by means of Y-laterals, and the four pipes extend to the power house, the last 600 ft. being reduced to 28 ins. inside diameter, each to serve one of the four waterwheels.

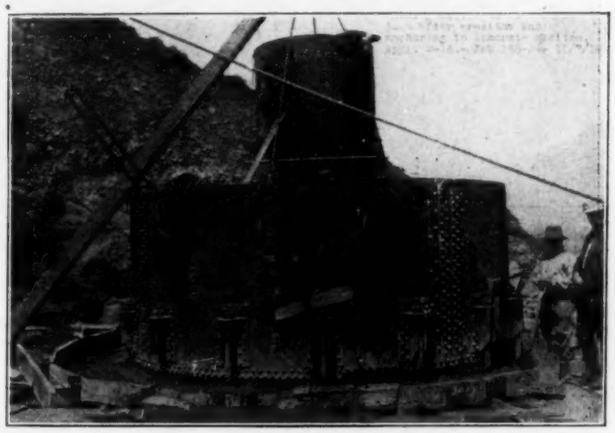
Standard construction is of pipes 20 ft. long, providing a length of 19½ ft. from center to center of joints. The joints are known as trumpet joints, with heel and spigot ends specially formed to receive rubber packing secured by cast-steel flanges and gland. The bell or female end of each pipe is the uphill end



Cerrillos Bridge on Pipe Line of Pangal Hydroelectric Development of Braden Copper Company.

and the shoulder of the bell rests in a molded concrete saddle. The pipes are therefore supported every 19½ ft. along their center line, and the nature of the joints is such that no other provision for expansion and contraction is necessary. Heavy concrete anchorages are provided at vertical breaks in alignment and elsewhere as required. A special flanged section with manhole is inserted immediately below each anchorage to facilitate repair or replacement anywhere along the line.

Each pipe is bedded and anchored into the concrete substructure of the power house and terminates in a heavy Johnson hydraulic valve for the control of flow to the wheel nozzle. The upper end of each 30-in. pipe line is also fitted with a Johnson valve and air inlet valve. These valves are about 2600 ft. from



Surge Tank at Pangal Hydroelectric Development, Showing Bottom Steel Section Just After Erection and Anchoring to Concrete Section.

the power house and are operated electrically from the switchboard. Any accidental break, resulting in a drop in pressure below these valves, will cause them to close automatically, and the time of such closure may be adjusted as desired.

Waterwheels.

The waterwheels are of the impulse type, direct-connected to horizontal-shaft generators. The runner disk is of annealed cast steel and is bolted to the flanged end of the generator shaft. The buckets are of annealed cast steel with spare sets of bronze for comparative trials against erosion, and are secured to the disk by press-fit steel studs. Great care has been taken in fitting the buckets and holding studs to insure accuracy and interchangeability. Each bucket has been brought to uniform weight and the complete number will remain accurately balanced even if parts are interchanged. The complete runner is guaranteed to withstand a runaway speed of 720 r.p.m. without causing stresses of more than 85% of the elastic limit of material in any part affected.

The manufacturer's guarantees as to performance, regulation, etc., of the waterwheels are based upon an operating speed of 360 r.p.m. and direct connection to an a-c. generator of 5000 kv-a., 90% power-factor and 400,000 ft-lbs. flywheel effort. At 1475 ft., net operating head, each wheel will deliver a maximum of 8700 hp. at 82% efficiency and 7300 hp. at maximum efficiency of 84%.

The power nozzle providing a jet of water for each wheel is at elevation 3015 ft. and is of the type known as a needle valve nozzle. This valve is operated by direct connection of the needle stem to the piston of a high-pressure service motor. The pressure medium is oil and its service to and from the motor is controlled by a hydraulic governor with speed element actuated by the generator shaft in the usual manner.

Direct connected to the power nozzle is an auxiliary relief nozzle of the same type and size. The

View From Diversion Dam of Rio Pangal Development, Looking Downstream and Showing a Section of the Seven-Mile Pipe Line.

auxiliary operates automatically, is subject to regulation, and its function is to prevent excessive pressure rise in the penstock from sudden drop in load without undue waste of water. Such pressure is limited to 10% for a decrease in load of any magnitude within the capacity of the equipment. In case of full load suddenly thrown on, the governor apparatus is capable of adjustment so as to limit the resulting pressure drop in the penstock to 15% below static.

Speed regulation is well within the standard practice for impulse wheels. The governor is equipped with hand-control mechanism and also with a hand-power high-pressure oil pump of sufficient one-man capacity to operate the service motor in emergency. A jet of water from the auxiliary relief nozzle or from the power nozzle in case of accident will not appear outside of the power house but will be caught and made inert by a vortex baffle plate secured in the masonry surrounding the wheel pit.

Power House.

Tailwater discharged by the wheels will be conducted to the river by underground concrete passages, where provision has been made to gage the quantity of water so discharged by standard weir measurement. It is expected that the tailwater side of this power house will be clear and accessible, even though impulse wheels are employed.

Oil at high pressure for the governor system is supplied by a central power-driven pumping plant, containing sump, pumps, accumulators, air compressor, filter, piping, etc. This plant is in duplicate as to pumps and accumulators and either side is capable of supplying the station. The pumps are driven by motors or by waterwheels interchangeably. Full supply of oil at constant pressure is insured by automatic control of the pump motors or waterwheels.

The superstructure of the power house is of reinforced concrete and contains the electrical machinery and apparatus and other features usual in generating stations of this kind.

The total static head obtained is 1595 ft., with pond surface at an elevation of 4610 ft., the crest elevation of the diversion dam as now built. This may be increased to 1665 ft. at some future time by raising the diversion dam.

The plant capacity will be 20,000 kv-a., available at the low-tension busbars of the generating station. When generating this amount of power the net operating head will be about 1460 ft. and the quantity of water utilized will be about 204 cu. ft. per sec.

The company owns and operates a hydroelectric plant located on the Cachapoal five miles below the new power station. The two plants will operate in conjunction. The transmission distance from the Pangal plant to Sewell is 18 miles.

All materials for construction (excepting those for concrete and some of the timber) and all machinery and apparatus have been shipped from the United States. All construction work is being done by the Braden Copper Co. through its own construction organization.

The hydraulic work for this plant was designed in detail by Hugh L. Cooper & Co., consulting engineers, New York, who have also supervised the manufacture of all parts shipped from the United States. The electrical work was designed by Percy H. Thomas, consulting electrical engineer of the Braden Copper Co.

NEW INSULATING MATERIAL.

A new product suitable for use in electrical insulation is being obtained from the treatment of kelp in Australia. The moist precipitate is subjected to pressure and formed under pressure, after which it is hardened by treatment with formalin. The finished article is made by turning on the lathe, a process which is said to be perfectly successful, and a high polish is applied. The raw product is to be found in large quantities around the coast of Australia and in particular on the Tasmanian shores.

Central-Station Rates in Theory and Practice

Twentieth Article—Arithmetical and Algebraic Analysis of Rate Schedules—Making Seemingly Involved Rates Simple — Calculations Simplified and Basic Errors Exposed

By H. E. EISENMENGER

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This series of articles, of which this is the twentieth, began in the issue of July 12. Part I included seven articles on the cost of electric service. Part II contained six articles on the principles determining the selection of a rate system. In Part III, comprising six articles, the various systems of rates found in practice were described. The present article opens Part IV on rate analysis; this subject will be concluded in next week's article. The remaining five articles will constitute Parts V and VI and deal with accuracy of rates and the practice of rate regulation by commissions.

PART IV—RATE ANALYSIS.

SECTION 157. In case of the more complex rate systems it is not easy to get a clear general conception of what the rate means to the various customers. It is, of course, very easy to figure out what the amount is which a certain given customer has to pay under the rate system, but that is not enough for a critical examination of the character of the rate. A little arithmetic, algebra or geometry can be applied with astonishing results to get an insight into the nature of a certain rate or rate system.

I. ARITHMETICAL AND ALGEBRAIC RATE ANALYSIS.

158. The arithmetical system of rate analysis has been demonstrated incidentally in a few of the simplest cases in the previous sections and will now be discussed more fully.

Let us call

a = the *amount* of the customer's total bill in cents for the period to which the bill applies.

d = the customer's maximum *demand* in kilowatts, horsepower, number of rooms, or whatever else the unit is.

e = the customer's *energy* consumption in kilowatt-hours.

Let us now take first the example of the straight meter rate, for instance, charging 10 cents per kw-hr. Then we obviously get $a = 10e$, or in the general case if z cents[1] are charged per kilowatt-hour we get $a = ez$.

Likewise, we get in a straight demand rate $a = dy$, where y is the demand charge in cents per kilowatt, horsepower, or per room, etc.

In a Hopkinson rate we get $a = dy + ez$

and in a Doherty rate: $a = x + dy + ez$,

where x is the specified customer charge.

Conversely, if we can express a rate by a formula composed of three members, one of them being constant (x), the second (dy) being proportional to the demand d, and the third (ez) being proportional to e, we have the equivalent of a three-charge system as follows: The member (x) which is free from demand and energy consumption is the equivalent customer charge, the member containing the demand d indicates the equivalent unit demand charge times the multiplier of d, and the member containing the energy consumption e indicates the equivalent unit energy charge times the multiplier of e. Since x, y or z, or any two of these values may be zero, we may accordingly get a two-charge or a single-charge system.

If we include those cases where one or two of the values x, y and z are zero, we can state that practically every rate system can be reduced to an equation of the type described and we have in every rate, whatever its apparent shape, the equivalent of a three-charge, a two-charge or a single-charge rate with the unit charges expressed in the way described above.

The quickest and easiest way to show the working and the principles of this arithmetical and algebraic analysis is to work out a few examples. The generalizing deductions will then offer themselves automatically.

159. Supposing we have a block meter rate which charges 10 cents per kw-hr. for the first 100 kw-hr. per month (first block), 9 cents per kw-hr. for the next 50 kw-hr. (second block), and 8 cents per kw-hr. for the balance (third block). The amount of the bill is then in the first block,

$$a = 10e$$

In the second block ($100 < e < 150$) it is

$$a = 10 \times 100 + 9(e - 100) = 100 + 9e$$

This means that all customers in the second block are charged just the same amount as they would have to pay under a rate having a customer charge of 100 cents ($1), plus an energy charge of 9 cents per kw-hr. We can thus say, although we have no customer charge *specified* in the rate system, yet we have the equivalent of a customer charge of $1. We have no equivalent demand charge, or, more accurately expressed, the equivalent demand charge is equal to zero.

Likewise we get in the third block

$$a = (10 \times 100) + (9 \times 50) + 8(e - 150)$$
$$= 250 + 8e.$$

The equivalent customer charge has increased to $2.50, the demand charge is still zero, and the energy charge has decreased to 8 cents per kw-hr.

A customer, for instance, who has used 200 kw-hr. will have to pay, being in the third block, 250 cents +

[1] Although the symbols x, y and z are usually employed to designate variable quantities, they are used in the following equations for the quantities: customer charge, unit demand charge and unit energy charge, respectively, although these charges are constant in the first rate systems to be discussed and the variables are d and e. The reason for this choice of symbols will become apparent later.

$(8 \times 200) = \$18.50$, which means a simplification of the computation even in this simple case.[2]

160. Next let us take the example of a plain Wright demand rate charging, for instance, 10.5 cents per kw-hr. for the first 35 hours' use of the demand, 8.5 cents per kw-hr. for the next 25 hours, 5 cents per kw-hr. for all the balance. In the first zone, block or "range," that is from 0 to 35 hours' use, we have

$a = 10.50e$; this means $x = 0$, $y = 0$, $z = 10.5$ cents per kw-hr.

In the second block (35 to 60 hours' use) the customer is made to pay for all kilowatt-hours which correspond to the first 35 hours' use of the demand at the rate of 10.5 cents per kw-hr. and the balance at 8.5 cents per kw-hr. The number of kilowatt-hours which corresponds to the first 35 hours of use of the demand d is $= 35d$ and the unit price to be paid for these $35d$ kw-hr. is 10.5 cents, so that the total price for them is $10.5 \times 35d$. The balance of $e - 35d$ kilowatt-hours is to be paid at 8.5 cents per kw-hr. and the total amount paid for that balance is therefore $8.5\,(e - 35d)$. The total bill is therefore

$a = (10.5 \times 35d) + 8.5\,(e - 35d) = 70d + 8.5e$.

This means a customer charge $x = 0$, a demand charge of 70 cents per kilowatt per month and an energy charge of 8.5 cents per kw-hr. (equivalent of a Hopkinson rate).

In the third block we get likewise $70d + 8.5e$ to be paid for the kilowatt-hours corresponding to the first 60 hours' use, that is for $e = 60d$, and 5 cents per kw-hr. for every kilowatt-hour of the balance. Therefore

$a = 70d + (8.5 \times 60d) + 5(e - 60d) = 280d + 5e$.

A customer having, for instance, 1.5 kw. demand and 100 kw-hr. energy consumption would have to pay $(280 \times 1.5) + (5 \times 100) = 420 + 500 = \$9.20$ Compare this simple calculation with the explicit method of figuring the price for 100 kw-hr. at 1.5-kw. demand under this rate:

I.	(35×1.5) kw-hr. $\times$ 10.5c/kw-hr.	$= 551.25$c
II.	(25×1.5) kw-hr. $\times$ 8.5c/kw-hr.	$= 318.75$c
III.	$(100 - 60 \times 1.5)$ kw-hr. $\times$ 5c/kw-hr.	$= 50.00$c
		920.00c

161. As the next example, consider the St. Louis Residence Lighting rate, which is a Wright demand rate on the number-of-rooms basis, but no longer a simple load-factor Wright rate but of somewhat more complicated specifications as given below. The charges are as follows:

8 cents per kw-hr. for the first 4 kw-hr. for each one of the first 4 active rooms, plus 2.5 kw-hr. for the excess rooms;

6 cents per kw-hr. for the excess up to 7 kw-hr per room for all active rooms;

3 cents per kw-hr. for the excess.

The unit for the demand d is here not the kilowatt but the active room. To determine the different "ranges" or "zones" in which the three unit kilowatt-hour charges of 8, 6 and 3 cents per kw-hr., respectively, apply, it is convenient to draw a diagram (Fig. 8), plotting the number of rooms in horizontal direction (as abscissæ) and the number of kilowatt-hours in vertical direction (ordinates). The 8-cent-per-kilowatt-hour zone reaches from

0 to 4 kw-hr. for 1 room
0 to 8 kw-hr. for 2 rooms
0 to 12 kw-hr. for 3 rooms
0 to 16 kw-hr. for 4 rooms.

This means, anything below the straight line OA in Fig. 8 is to be paid at 8 cents per kw-hr. For 5 rooms and upwards we have to add only 2.5 kw-hr. for each room, which means the 8-cent-per-kw-hr. zone reaches

from 0 to 18.5 kw-hr. for 5 rooms
0 to 21 kw-hr. for 6 rooms
0 to 23.5 kw-hr. for 7 rooms
.....etc....., see line AM.

The range below the line OAM is therefore a straight meter rate at 8 cents per kw-hr. or $a = 8e$.

The 6-cent-per-kw-hr. zone (zone 2 in Fig. 8, consisting of $2a$ and $2b$) reaches from this line up to the line ON, which represents 7 kw-hr. per room (7 kw-hr. for one room, 14 kw-hr. for 2 rooms, etc.). What is the equivalent three-charge system in this zone?

Dealing first with that part where the number of rooms is not greater than 4 (zone $2a$), we find in the same manner as before (using the symbol d for the demand in rooms):

$a = (8\text{c/kw-hr.} \times 4d) + 6\text{c/kw-hr.}(e - 4d)$
$= 8d + 6e$ ..... (1)

The customer charge $x = 0$, the demand charge $y = 8$ cents per room per month, and the energy charge $z = 6$ cents per kw-hr.

Where the number of rooms is greater than 4 (zone $2b$) we have to pay 8 cents per kw-hr. for a certain number f kw-hr. and 6 cents per kw-hr. for the balance, so that

$a = 8f + 6(e - f) = 2f + 6e$ ..... (2)

where f is composed of two parts: 4 kw-hr. for every one of the first four rooms and 2.5 kw-hr. for every room in excess of 4, so that $f = (4 \times 4) + 2.5(d - 4) = 6 + 2.5d$. Substituting this into the equation (2) we get

$a = 12 + 5d + 6e$ ..... (3) zone $2b$

We see, therefore, that for all customers in this range ($d > 4$ rooms) the equivalent of a three-charge system applies with

a customer charge $x = 12$c per customer per month,
a demand charge $y = 5$c per room per month, and
an energy charge $z = 6$c per kw-hr.

Thus this is practically a Doherty rate, although the rate schedule mentions nothing but kilowatt-hour charges.

On the dividing line between the two portions $2a$ and $2b$ of the 6-cent-per-kw-hr. zone, that is, for $d = 4$ rooms, we can, of course, use either of the formulæ (1) or (3) as each one furnishes $a = 32 + 6e$ for $d = 4$. Likewise, we can, of course, use the formula for either zone on the dividing line between any two zones in any rate system, because the formulæ must of necessity furnish identical numerical results for the dividing line that lies between them.

The bill in the third zone (3-cent zone) where $e > 7d$ (zone 3, consisting of $3a$ and $3b$) is figured for $d < 4$ (zone $3a$ in Fig. 8) in analogy with what has been explained previously [using equation (1)] $a = 8d + (6 \times 7d) + 3(e - 7d) = 29d + 3e$ (equivalent of Hopkinson rate).

Or, if we wanted to work this out without reference to formula (1), applying to the second zone, we

[2] Using general symbols where z_1, z_2, z_3... are the energy charges in the first, second, third, etc., block and e_1, e_2, e_3... are the sizes of the successive blocks in kilowatt-hours we get in the first block $a = ez_1$
in the second block, that is for energies between e_1 and e_2 kw-hr.,
$a = e_1z_1 + (e - e_1)z_2 = e_1(z_1 - z_2) + ez_2$
The customer charge is $e_1\,(z_1 - z_2)$, the energy charge is ez_2.
In the third block: $a = e_1z_1 + e_2z_2 + (e - e_1 - e_2)z_3$
$= \underbrace{e_1(z_1 - z_3) + e_2(z_2 - z_3)}_{\text{Customer Charge}} + ez_3$
Energy Charge $= ez_3$. Likewise we get analogous terms for the customer and energy charge in the following blocks.

get $a = (8 \times 4d) + 6(7-4)d + 3(e-7d)$ with the same result as above.

For the third zone with $d > 4$ (zone 3*b* in Fig. 8) we get, using the formula (3) for zone 2*b*, as far as that zone applies, that is up to $e = 7d$, $a = 12 + 5d + (6 \times 7d) + 3(e - 7d) = 12 + 26d + 3e$; this means $x = 12$ cents per customer per month, $y = 26$ cents per room per month, and $z = 3$ cents per kw-hr. (equivalent of Doherty rate).

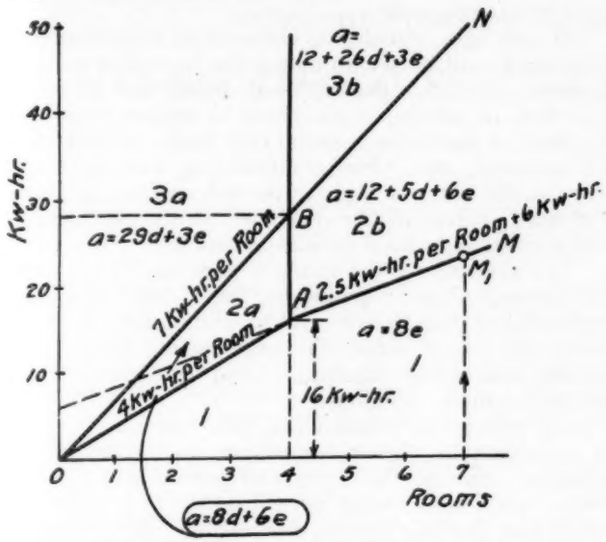


Fig. 8.—Analysis of Number-of-Rooms Rate.

162. Another example for the working of this method will be given in the analysis of the High-Tension Wholesale Lighting and Power rate of Boston. This rate is a double-block Hopkinson demand rate as follows:

Demand charge
\$60 per year per kw. for first 15 kw. of demand
36 per year per kw. for next 40 kw. of demand
30 per year per kw. for next 100 kw. of demand
15 per year per kw. for next 100 kw. of demand
12 per year per kw. for excess demand
plus an energy charge of
5 cents per kw-hr. for the first 1,500 kw-hr.
3 cents per kw-hr. for the next 4,000 kw-hr.
1.5 cents per kw-hr. for the next 50,000 kw-hr.
1.25 cents per kw-hr. for the next 50,000 kw-hr.
..... etc. .....

We will restrict ourselves to the investigation of the rate for such customers who come into the highest demand block ($d > 255$ kw., or the \$12 demand block) and into the energy block of more than 55,500 kw-hr. per month (1.25-cents-per-kw-hr. block).

$$a = (6000 \times 15) + (3600 \times 40) + (3000 \times 100) + (1500 \times 100) + 1200(d - 255) + (5 \times 1500) + (3 \times 4000) + (1.5 \times 50{,}000) + 1.25(e - 55{,}500) = 403{,}125 + 1200d + 1.25e \text{ (in cents)}.$$

We see that we have in this rate a very considerable customer charge amounting, for instance, to \$4031.25 per month per customer for all customers with a demand over 255 kw. and an energy consumption between 55,500 and 105,500 kw-hr. Yet the rate schedule mentions only demand and energy charges.

163. The great importance and extreme usefulness of a proper rate analysis is clearly demonstrated in the following example of a rate of a large company in the West which the present author analyzed in the *Journal of Electricity, Power and Gas* of July 27, 1912. Quoting from there: Under the rate the consumer had to pay a certain monthly fixed charge f cents per kilowatt maximum demand; let us say[3] \$4 per kw. ($f = 400$ cents). This entitles him to use current up to the load-factor L (for instance, $L = 300$ hours' monthly use of the maximum demand), the excess to be paid at z cents per kw-hr. (for instance, 2.5 cents per kw-hr). Without mathematical analysis, this rate looks perfectly correct and harmless, and it was not until the customers themselves happened to find out the defects and took advantage thereof that the rate was revoked. With a little mathematical analysis, as follows, the defects of the rate would have shown up glaringly at once and the rate would never have been put into effect.

In the range of load-factors smaller than L hours (300 hours) we have $a = fd$, where a is again the customer's bill and d his maximum demand; and if L is larger than 300, the customer with a total energy consumption of e kw-hr. has to pay, on top of this, for the excess of e over Ld kw-hr. at the rate of z cents per kw-hr., so that his total bill will be:

$$a = fd + (e - Ld)z = (f - Lz)d + ez \quad \ldots\ldots\ldots\ldots\ldots\ldots (4)$$

The first term on the right side is proportional to d and independent of e; the second term is proportional to e and independent of d. Consequently, $f - Lz$ is the equivalent demand charge and z is the equivalent energy charge in the range of load-factors larger than L hours.

Substituting now the above values from the schedule for f, L and z, we get

$$a = (400 - 300 \times 2.5)d + 2.5e = -350d + 2.5e.$$

We thus have a *negative* demand charge of \$3.50 per kw.!

In other words, all the customer has to do in order to reduce his bill—provided he has a load-factor of more than 300 hours' use per month—is to *increase* his maximum demand before the meter reader comes, with as little increase of the energy consumption as is feasible, until he has reduced the load-factor to 300 hours per month. For instance, let us assume his demand meter reads 50 kw. near the end of the month and his kilowatt-hour meter 30,000 kw-hr.; his bill therefore would be

$$50 \times 400 = 20{,}000 \text{ cents}$$
$$(30{,}000 - 50 \times 300) \times 2.5 = 37{,}500 \text{ cents}$$
$$57{,}500 \text{ cents} = \$575.$$

If now, before the meter reader comes, the consumer for a short time purposely puts on a heavy load on his motors, or for instance lets them all work simultaneously (instead of with the diversity they show under ordinary operation) and thus runs his maximum demand meter up to 80 kw. with a practically unchanged kilowatt-hour consumption, he will have to pay

$$80 \times 400 = 32{,}000 \text{ cents}$$
$$(30{,}000 - 80 \times 300) \times 2.5 = 15{,}000 \text{ cents}$$
$$47{,}000 \text{ cents} = \$470.$$

He has increased his demand by 30 kw.; therefore, his bill must be smaller by $30 \times \$3.50 = \$105$. This reduction of the bill with increasing maximum demand of course goes on until the load-factor is reduced to 300 hours.

To avoid this drawback with a rate of the type quoted we must choose f, L and z so that $f \gtrless Lz$, then the demand charge will be $\gtrless 0$, as equation (4) dem-

[3] The figures are changed for obvious reasons, but in such a way that the characteristic features of the rate are preserved.

onstrates. If, for instance, we maintain f at $4 per kilowatt and s at 2.5 cents per kw-hr., L must not be chosen larger than $400/2.5 = 160$ hours per month. If f is just equal to Ls (in our case, if L is chosen at just 160 hours per month) the demand charge is zero and the rate for all customers with a load-factor above 300 hours is a straight kilowatt-hour rate; if $f > Ls$ ($L < 300$ hours' use) the rate for all load-factors above L is a Hopkinson rate. In both cases the rate for all load-factors $< L$ is a straight demand rate

(To be continued.)

THIRD HARMONICS IN ALTERNATOR WINDINGS.

Peculiarities of Harmonic Voltages and Their Effects on Grounding Practice of Large Systems.

The third harmonic is the most troublesome of all harmonic voltages and is present in practically all generator windings. Unless steps are taken to deal with it from the commencement, says L. C. Grant in the London *Electrical Review*, it is likely to give a great deal of trouble to those having to deal with the working of electrical plant.

The harmonic frequency may be such that it runs in opposition, or, on the other hand, it may run in phase, with the power waves. In the former case the respective voltages coincide at their peak values, giving to the power wave a peak formation; when, however, the waves are in phase the peaks do not coincide and the power wave is altered in an entirely different manner. This results in a flattened formation, with a dip instead of a peak, but broadens out the wave considerably. Should the harmonic be entirely out of phase—not out of step, of course—it merely results in a complicated wave form, in which the two halves of the cycle are dissimilar.

With a polyphase generator the phase windings have an important bearing on the harmonic voltages. Should the machine be wound in delta, a difference in potential will exist at various points of the delta, which should normally be at similar potential; this results in circulating currents flowing through the windings which will dissipate the harmonic, but in a questionable manner.

Now, if the phases are connected in star, the line voltage will be the sum of two phase voltages displaced by 60°. The result of this phase displacement is that all harmonic frequencies are displaced by a like amount. For the third harmonic this means that the frequencies are displaced in each phase by half a cycle, resulting in their cancelling one another through being in opposition. Obviously the same holds good with any other harmonic frequencies which are a multiple of three. Thus, as far as the line is concerned, the third harmonic is wiped out. It must be borne in mind, however, that the harmonic frequencies still exist between any phase and the neutral point of the star.

With generators operating in parallel it is usually necessary to ground the neutral point, to limit and define the voltage to earth and also to allow the protective apparatus to operate. It is also essential that one generator neutral be grounded if absolute reliability is to be depended upon, as in case of a generator failure should only one neutral be grounded, and this machine be the one to fail the supply system will then be minus a neutral and circuit-breakers will be rendered useless.

On the other hand, should there be more than one neutral connected to earth all phases will be paralleled through the neutral points and earth, and the harmonic voltages again exist and may assume extremely dangerous proportions. In consequence it becomes necessary to ground through some current-limiting device such as a resistance or reactance; a reactance is advantageous in that it has a much greater impedance for third and any other harmonics than for the power frequency.

In any case, circulating currents of greater or less magnitude will be set up unless the harmonic voltages happen to coincide exactly at all points and all times, and this, of course, is too much to expect, even with the best of machines with varying loads, irregularities of material, etc. These circulating currents may very easily reach a high value and can be up to the full-load current of the machine; hence the value of the neutral resistance or similar device.

On account of the modern generator now being of purposely high reactance in itself, third and other harmonic trouble is not now so pronounced as it was some years back, when the main feature in generator design was good regulation, and consequently low reactance in the windings.

As previously pointed out, this reactance opposes a considerably higher impedance to harmonic frequencies than to the power frequency, and thus, in some cases, it is found quite feasible to parallel two generator neutrals directly without the use of external current-limiting devices.

In grounding generator neutrals it is always advisable to use a fairly heavy oil switch and to include an ammeter in the circuit, as with the two machines it is not possible to gauge even approximately the earth current by comparison with machine and feeder readings, owing to the wide variation that may exist in the load and earth components.

TESTS OF TELEPHONE RECEIVERS FOR RADIO USE.

Bureau of Standards Determining Best Types of Receivers for Specific Radio Purposes.

A comprehensive study of the telephone receivers used in radiotelegraphy and in radiotelephony is in progress at the Bureau of Standards, Washington, D. C. The tests include measurements to determine the loudness of response given by different types of telephones, as well as the electrical characteristics which determine how satisfactorily they fit the electrical apparatus in which they are used. Accurate methods are being devised for these measurements. It is expected that observations will be made by a large number of persons, so as to express results in terms of the average ear. It is also expected to use an electrical or artificial ear, and determine the relation of the average ear to this device which will then serve as a standard.

The results of these tests should make it possible to determine which type of receiver is required in a given radio apparatus in order to obtain the loudest signals. The methods developed will be of value in making measurements of the strength of signals received at radio receiving stations and will be utilized in connection with a study of the properties of electric waves, in which it is expected to obtain the co-operation of a large number of observers throughout the country.

Limitations and Performance of Large Steam Turbines

Papers Presented Before New York Meeting A. I. E. E. —Salient Features Given in Somewhat Abridged Form

Present Limits of Speed and Power of Single-Shaft Curtis Turbines

By Erskil Berg
General Electric Co.

FOR the purpose of discussing the limitations of the types of turbines used in the more important work now done by the General Electric Co. and to show the relative results which can be accomplished with such designs under different conditions of load, two machines have been selected, one representative of the largest size built for 1800 r.p.m. and one of the largest size now built for 3600 r.p.m. The figures given relate to the turbine alone and do not include generators.

The turbines in question are both of the single-flow type and may be considered representative of capacity limitations of that type. The single-unit turbine and generator is naturally preferable over the tandem and compound type on account of simplicity, lightness and efficiency. There are, however, certain definite limitations in the size for a given speed that these units can be built with material available at the present time. The limitation in the size of a unit for a given speed is entirely dependent upon the turbine and not upon the generator.

Fig. 1 shows the load curve of the large 1800-r.p.m. machine above mentioned, designed to operate with 250 lbs. steam pressure, 28.5 ins. vacuum and dry steam. This turbine has 23 stages, all wheels being of the single-bucket type. The first stage wheel has a pitch diameter of 35 ins., which increases with each successive stage until the last wheel, which has a pitch diameter of 88 ins. This curve shows that for 1800 r.p.m. a turbine can be designed for a 28.5-in. vacuum, giving its best efficiency at 21,000 kw. This curve also shows that with a sacrifice of 5% in efficiency, an output of 36,000 kw. can be delivered to the turbine shaft. Above a load of 21,000 kw. live steam is bypassed to the eighth stage shell, the effect of which is shown by the break in the curve.

The dotted line gives the load curve of a similar turbine in which the first 11 stages are replaced by one two-bucket stage. This turbine is designed with multiple valve steam admission, a modification that may be desirable for the purpose of simplification or where better efficiency at very light loads is important, as in propulsion of warships.

Many large size turbines are now designed for a vacuum of 29 ins. The volume of 1 lb. of steam at this vacuum is 652 cu. ft., almost 50% greater than at 28.5 ins., and about twice as much as at 28 ins., which calls for a corresponding increase in the area of the steam passage in the last stage wheel. If this area is made too small, the steam when leaving the last row of buckets must have a high velocity, giving a large loss of energy, this loss being in proportion to the square of the velocity. That this area be made as large as possible and that the exit angle of the blades be made small enough to give good extraction is therefore important.

Efficient action can only be accomplished by using a bucket speed that bears a proper relation to the steam velocity. Consequently to get the largest capacity, long buckets moving at a very high speed must be used. In order to obtain good bucket action, the buckets should not be more than about one-fourth as long as the pitch diameter of the wheel. If made longer than this, poor bucket action with consequent loss in efficiency will result, due to the great difference in peripheral speed between the base and the tip of the bucket, the design being made correct for the middle point or pitch line. The flare also becomes excessive so that the space between the buckets at the tip will be so large that steam can flow between the buckets without doing any work.

The use of a high steam speed in this last stage naturally implies that a relatively large proportion of

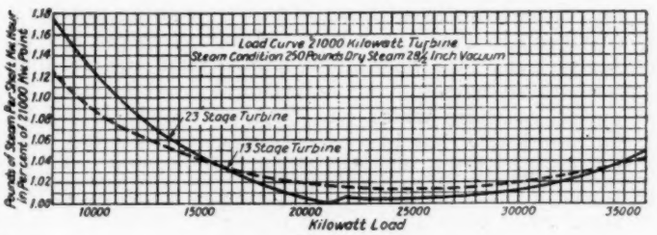


Fig. 1.

the total steam energy must be utilized there. Such concentration of work into a single stage has its disadvantages, since even if the best relation of velocities is maintained, such a stage doing a large amount of work is naturally less efficient than one of similar character doing less work.

The design of the last stage in such a turbine constitutes the most important limitation. The large 23-stage 1800-r.p.m. turbine already mentioned is designed to operate at 250 lbs. steam pressure, 28.5-in. vacuum and dry steam. The pitch diameter of the last wheel is 88 ins., length of buckets 22 ins. and bucket angles 60 deg. entrance and 40 deg. exit. The wheel is subject to the following stresses at normal speed:

Stresses in hub, 23,450 lbs. per sq. in.
Stresses in web, 22,950 lbs. per sq. in.
Stresses in bucket, 20,100 lbs. per sq. in.

Elastic limit (limit of proportionality) of material, 55,000 lbs. per sq. in. The material of the wheel and bucket is quenched and tempered 3% nickel steel.

The wheel is stiff enough to avoid vibration effects and in the absence of such effects the centrifugal strains afford ample factors of safety even if we

assume considerable irregularities and imperfections of metal structure.

Cause of Wheel Breakages.

In some of the first large machines of the type here discussed, very serious trouble has developed due the formation of cracks in the forged wheels, causing

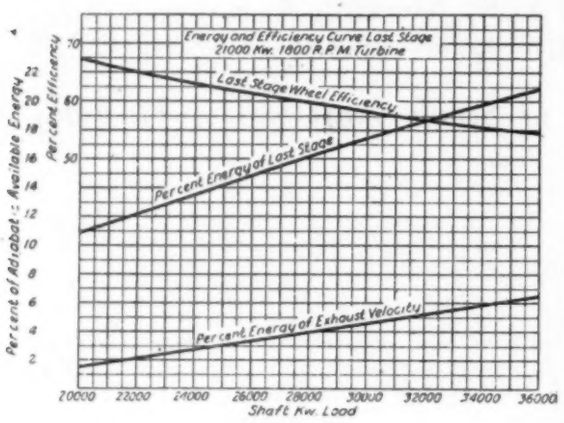

Energy and Efficiency Curve Last Stage
21000 Kw. 1800 R.P.M. Turbine
Last Stage Wheel Efficiency
Percent Energy of Last Stage
Percent Energy of Exhaust Velocity
Percent of Adiabat = Available Energy
Percent Efficiency
Shaft Kw. Load

Fig. 2.

wheels to break in three important installations. The cracks formed in these wheels have started at holes in the wheel provided either for balancing steam pressures on the two sides of the wheel or for the attachment of balance weights. Calculation showed that the wheels which broke were less stressed than many which were made from weaker metal and had operated for long periods of time. Holes in a centrifugally stressed wheel greatly increase the fibre stress in the vicinity of the hole itself, but such conditions had not caused the formation of cracks in large numbers of wheels in which such localized high stresses existed. Many evidences have now shown that the trouble with these wheels has not resulted from stresses in excess of those which had been previously found to be practicable, but has been caused by fluttering and vibrations of the wheels, which had become possible through the lightness and thinness of their construction. Such vibrations give a periodic character to the stresses normally imposed and so give rise to the formation of fatigue cracks.

In machines of this type relatively light and narrow buckets have been used and the wheels have been

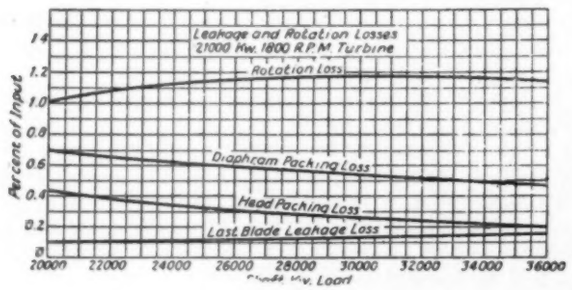


Fig. 3.

proportioned with a view to ample centrifugal strength but with maximum economy of space and weight, consequently these wheels have had much less lateral stiffness than wheels used in turbines of previous types. To overcome such troubles as have developed, it is simply necessary to make the wheels stiffer and to put in holes in parts of the wheel near the hub where a suitable reinforcement of thickness can be provided which both stiffens the wheel and reduces stresses near the holes. Very slight changes of this kind make a great difference in the vibrating characteristics of such wheels, and the proportions used are such that they can easily be brought to the same standards of safety in these respects as have long prevailed in wheels of heavier construction in machines having less numbers of stages.

In the absence of a tendency to form fatigue cracks through vibration, overspeed in such turbine wheels involves relatively little danger as compared with other types of high-speed machinery. Experimentally and in actual service, wheels have been stretched to a considerable degree of enlargement without the formation of any cracks, and such stretching is a normal condition if the cracks do not exist.

It has been discovered that such fluttering or vibration of the web of wheels has not only been responsible for the formation of fatigue cracks in the wheels themselves, but has also caused loosening and breakage of buckets. The remedy is to use stiffer wheels, and such wheels can carry stiffer buckets, so that the whole structure is incapable of vibration of any amplitude through such forces and periods as arise from the conditions of operation.

Fig. 2 gives the energy and efficiency curves of this last stage. It will be noticed that at the most efficient

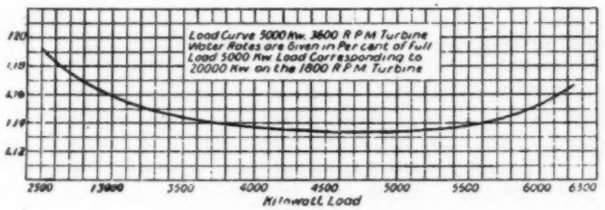

Load Curve 5000 Kw. 3600 R.P.M. Turbine
Water Rates are Given in Per cent of Full
Load 5000 Kw. Load Corresponding to
20000 Kw. on the 1800 R.P.M. Turbine
Kilowatt Load

Fig. 4.

point (21,000 kw.) this stage absorbs 11.5% of the total adiabatic available energy and that the wheel efficiency is 66.25%. The energy represented by the exhaust velocity which is all wasted in the condenser is 1.5% the total energy. As the load increases on the turbine shaft, the energy in this stage also increases, decreasing its efficiency until at 36,000 kw. the energy in the last stage is 20.9% of the total energy. The wheel efficiency however has been reduced to 54.2% and the energy represented by the exhaust velocity has been increased to 6.4%. This great amount of work in the last stage at such poor efficiency naturally lowers the efficiency of the whole turbine, and in this case the efficiency at 36,000 kw. is 5% lower than at 21,000 kw.

Fig. 3 shows leakage and rotation losses of the same turbine in percent of input. From the above it will be seen that for 1800 r. p. m., a turbine can be designed efficiently for 21,000 kw. which, with a sacrifice of efficiency can deliver 36,000 kw.

Fig. 4 gives a load curve of the smaller 3600 r. p. m. turbine. The water rates are here given in reference to that of the larger machine, the load of 5000 kw. corresponding to that of 20,000 kw. on the 1800-r. p. m. turbine. This turbine has only five stages, one two-bucket wheel in the first stage, the other four stages having single-bucket wheels. The first wheel has a pitch diameter of 35.5 ins., and the remaining four wheels a pitch diameter of 51 ins. The bucket height of the last wheel is 9.125 ins., the turbine being designed for a maximum of 6250 kw.

The reason for such a discrepancy in the number of stages calls for explanation. As the output

of a turbine, keeping approximately the same stresses, goes up inversely as the square of the r. p. m., if the same number of stages could be used and clearance and all dimensions proportionately reduced, a 5000-kw. machine at 3600 r. p. m. could be made nearly as efficient as a 20,000-kw. machine at 1800 r. p. m., and developments of smaller multi-stage machines at our Lynn Works have already been made which approximate such possibilities. Constructions however which are practicable on a large scale are not practicable on a small scale, consequently there are difficulties in getting the space economy in small high-speed machines which would be necessary for accomplishing the result stated. One of the difficulties has lain in the construction of diaphragms, the casting in of nozzle partitions being easy in a large diaphragm and very difficult on a small one. We are working upon types of diaphragms and other parts which may make possible the development of multi-stage high speed machines which afford improved degrees of economy.

If a 10,000-kw. turbine is designed for 1800 r. p. m., the only change necessary would be to make the nozzle and bucket heights about half the height of those in the 20,000-kw. unit. This reduction in height of buckets and nozzles would affect the weight, size, and cost of the turbine very little as compared with the 20,000 kw. unit. In regard to economy, the lower bucket heights would reduce the rotation loss somewhat but far from 50%. The diaphragm packing loss, head packing losses, and bearing losses would be practically the same as on the 20,000-kw. unit, so that while a turbine designed for 10,000 kw. would be more economical than the large turbine running at half load, the difference would be small, being only about 6%.

It will be seen from this paper that for a given speed there is one particular size of turbine which can be designed to be most economical as to steam consumption, weight, space, and price per kilowatt. Even if a size smaller than this is required, it would in many instances pay for the central station to install the larger unit, even though it would have to run at reduced load for some time before the station load increased sufficiently to utilize the full capacity.

Present Limits of Speed and Power of Single-Shaft Turbines

By J. F. Johnson
Westinghouse Electric & Manufacturing Co.

With the employment of high vacua, such as is the present universal practise, the limit of power of a turbine operating at a given speed will be determined largely by the area obtainable through the last stage for the final expansion and passage of the steam power to its entering the condenser. The significance of this will be apparent when attention is called to the fact that whereas a pound of steam, when entering the first stage, has a volume of less than 2½ cu. ft., when passing through the last stage it has a volume of approximately 395 cu. ft. when expanded to 28½ ins. vacuum, and 585 cu. ft. when expanded to 29 ins.; a ratio in the latter case of 1 to 234.

Consequently, in any discussion of limits of power, it will be necessary to assume conditions of pressure and superheat of the steam entering the turbine, the vacuum to which the steam is to be extended in the blading, and the efficiency or rate of steam flow per unit of power. For these conditions 250 lbs. gage pressure with 200 deg. F. superheat and 29 ins. vacuum referred to a barometer of 30 ins., and efficiencies as are commonly obtainable with them, will be used.

Limiting factors may be divided into three classes: First; Theoretical, including limiting steam velocities and effect on efficiency of velocity remaining in steam after leaving the last stage, and the area through the blades as affected by blade angle. Second; Physical, including methods of construction, material, stresses, factor of safety against rupture, reliability factor, and limitations of transportation facilities. Third; Economic, including limits beyond which it may be physically possible, but economically inadvisable, to go, such as effect of size of structure or of character of materials employed on cost, and time required to make inspection and repairs. This paper will be restricted to a discussion of some of the factors which determine or influence such limits as applying particularly to turbines of the reaction type.

Theoretical Limits.

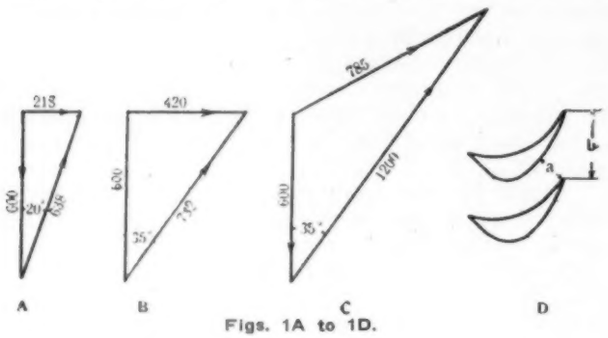
In this class there are but few limitations as affecting capacity at a given speed because with materials of infinite strength and rigidity available it would be possible to build units of infinite capacity; but for a given diameter and blade height the capacity will be limited by chosen maximum values of steam speed through the blades, in order to keep the leaving losses, or available energy in the steam discharged to the condenser, within permissible limits. Throughout the entire turbine, with the exception of the last few stages, steam speeds only about 25% in excess of the corresponding blade speeds are employed in order to secure maximum efficiency. In the latter stages, however, the volumes become so great that a compromise between maximum theoretical efficiency and physical dimensions becomes advisable by increasing the steam speed sometimes to approximately 100% in excess of the blade speed. The steam after being discharged from the last stage, therefore, still contains a small portion of available energy the recovery of which would involve disproportionate expense.

For example, if the pressure drop in the last stage is such as to render available for work thirty heat units which will produce an equivalent velocity of 1225 ft. per sec., and if the blade speed is such that the steam after leaving it still has a velocity of 600 ft. per sec., which is the equivalent of 7.2 B. t. u., this 7.2 B. t. u. will be totally lost, whereas probably 80% of it (or 6 B. t. u.) might be recovered were it practicable to use an additional stage of proper proportions. This would improve the total efficiency of the turbine approximately 1½%. Higher blade speeds will tend to improve the efficiency by reducing leaving losses, but generally not as effectively as would larger blade areas with lower steam velocities and correspondingly increased number of stages.

With height of a row of blades fixed, the area of the steam space is dependent upon the angle formed between the center line of the row of blades and the outlet portion of the blade. The smaller this angle is the smaller will be the area and vice versa. On the other hand the smaller this angle the higher the efficiency because of the lesser absolute velocity left in

the steam leaving the last stage to discharge to the condenser.

In Fig. 1A is shown a relation between steam speed and blade speed to give highest efficiency. The blade speed is 600 ft. per sec., steam speed 638 ft. per sec., blade angle 20 deg. and steam speed after leaving



Figs. 1A to 1D.

blades, 218 ft. per sec. in direction at right angles to direction of rotation. Fig. 1B shows a similar condition giving maximum obtainable efficiency employing a 35 deg. blade angle and Fig. 1C a condition in which the steam speed is 100% greater than the blade speed.

The leaving losses are, in Fig. 1A, 218 ft. per sec., Fig. 1B, 420 ft. per sec., and Fig. 1C, 785 ft. per sec., which is the equivalent of 0.95, 3.5, and 12.3 B. t. u. respectively.

The steam area is ordinarily expressed as a ratio of the perpendicular distance between blades, to the pitch of the blades, as a/b (see Fig. 1D). Highest actual efficiency is obtainable by keeping this ratio between 0.25 and 0.3, and this is done in all stages except the last few in high vacuum machines where it is increased to a maximum of 0.5, the equivalent angle being about 35 deg. which includes proper allowance for blade thickness; this ratio having been determined upon as a proper compromise between cost of increased blade height and loss of efficiency due to increased terminal loss.

Some European manufacturers have employed ratios as large as 0.65 and 0.7.

Physical Limits.

Chief among the physical factors limiting turbine capacity are the physical characteristics of the material employed and the chosen limits to which these materials may be safely stressed, bearing in mind that either uniformity of quality, or factor of safety sufficient to cover all possible variations, together with inaccuracies in calculation and irregularities of operation, must be provided for. While alloy steels possessing exceptionally high physical characteristics are procurable, their high qualities depend on relatively sensitive metallurgical processes which in the opinion of some engineers cannot as yet be carried out by regular workmen as a manufacturing process with a sufficient degree of reliability to justify their use, and that until this can be done, conservatism demands adherence to the lower strength, lesser sensitive materials. Such materials may, with suitable forms of construction, be safely stressed under the maximum test condition to within a few thousand pounds of their true elastic limits.

When the construction of the rotor is not limited to any one special form, the design may be varied so as to take full advantage of the low speeds in the high and intermediate stages (where low speeds must be used in order to secure high efficiency) by employing a drum the thickness of which may be varied to keep the stresses within desired limits; while in low-pressure stages where the stresses are highest, either disks carried on a shaft, or solid disks suitably held together, may be employed. With the solid disk construction the stresses may be kept within any reasonable limits up to speeds at which the design becomes too massive and expensive.

The steel regularly used by the Westinghouse company for turbine rotors conforms to the following characteristic specifications:

Test rings taken as close as possible to the point of maximum stress must show the following characteristics with standard 2-in. specimens:
Tensile strength 65,000 to 70,000 lbs. per sq. in.
True elastic limit 22,000 to 25,000 lbs. per sq. in.
Elongation 15% of 18%.
Reduction of area 20% to 25%.
The steel must be of best quality, having approximately 0.25% carbon, 0.50 to 0.60% manganese, 0.25% silicon, and not over 0.025% sulphur or of phosphorus.

The material is obtained ordinarily in the form of castings, though occasionally as forgings. The specifications in either case are the same. Especially in the larger sizes the forgings have been difficult to obtain, excessively expensive, and no more uniform or reliable in quality than the castings.

Fig. 2 shows the form of casting for a rotor end. It is cast vertically with the small end down, and after casting is allowed to cool very slowly in the sand. After removal, the entire upper portion which constitutes the riser, is cut off and the casting then thoroughly annealed by being heated slowly and evenly to a temperature of about 1650 deg. F. and allowed to cool very slowly. It is then rough machined to within about ¼ in. of finished surface, after which it is put in a furnace and heated to about 1100 deg. F. and allowed to cool slowly to remove any possible internal stresses set up by reason of the metal removed in machining. It is then finish machined and given no further treatment of any kind.

The limit of stress to which this material is subjected is 20,000 lbs. per sq. in. when operating at a speed 20% in excess of the normal operating speed.

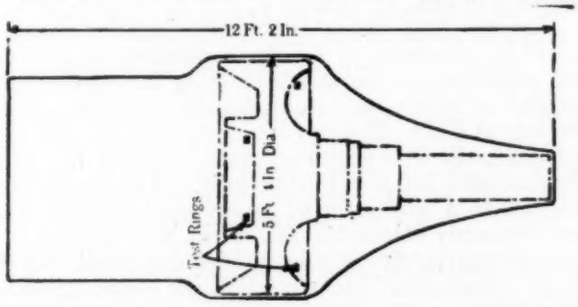


Fig. 2.

The stress at normal speed is therefore $\frac{20{,}000}{(1.20)^2} =$ 13,900 lbs. This stress is 63% of the minimum allowable true elastic limit, about 46% of the yield point and 21½% of the minimum ultimate strength. It is not generally appreciated that should the stress, by reason of defect or excessive overspeed, exceed the true elastic limit, no injury will result other than a slight permanent stretch, together with such blade damage as may result therefrom. In an extreme case of overspeed the rotor drum or solid disk will stretch

sufficiently to cause blading to rub to such an extent as to practically insure entirely destroying it, and thus prevent further overspeed, before the ultimate strength and elongation of the material is reached.

If the rotor design can be so modified as to always keep the stresses within necessary limits, then the stress at the base of the blades, or in blade fastenings, determines the maximum capacity obtainable with a given speed.

There exists two interesting relations between the stress at the base of blades, steam passage area through the blades and rotative speed. For any given rotative speed and blade angle, the steam capacity or steam area through the blades is directly proportional to the stress at the base of the blades, regardless of the diameter and blade height selected. This stress can only be modified by unevenly varying the cross sectional area of the blades such, for example, as thickening the blade near the base. Also for any given stress the area through the blades will vary inversely as the square of the speed, i. e., if at a speed of 1800 r.p.m. a given stress and area are obtained, then at 900 r.p.m. the area will be increased four times if the stress is kept constant.

The area and stress are therefore each equal to a constant times the product of mean diameter and blade height, and when the stress is constant this product will vary inversely as the square of the revolutions per minute. The ratio of blade height to rotor diameter is, therefore, not a factor in determining physical limit of capacity, but only in determining efficiency, cost and, to some extent, reliability of the turbine.

Blading used in impulse stages and in low pressure reaction stages in which stresses exceed 15,000 lbs. per sq. in. at 20% overspeed is made of a 5% electric furnace nickel steel in which the carbon sulphur and phosphorus are kept very low. It is really a nickel iron having a very fine close structure.

Its physical and chemical characteristics are as follows:

Tensile strength	65,000 lbs. per sq. in. minimum
True elastic limit	35,000 lbs. per sq. in. minimum
Elongation in 2 ins, %	30
Reduction of area, %	60
Carbon, %, not over	0.08
Silicon, %, not over	0.10
Phosphorus, %, not over	0.025
Sulphur, %, not over	0.04
Manganese, %	0.40 to 0.50
Nickel, %	4.5 to 5.5

This material is annealed by heating to 1425 deg. F. and cooled in open air after rolling into sections required for forming into various blade shapes and is given no further heat treatment.

The maximum stress at 20% overspeed to which this material is subjected is 25,000 lbs. The corresponding stress at normal speed is, therefore, 17,350 lbs., this being 49% of the true elastic limit and 26½% of minimum ultimate strength.

For the lower stress reaction blading, a copper, tin and phosphor bronze is employed, consisting of:

Copper, %	97 to 98
Tin, %	2 to 3
Phosphorus, %	0.03 to 0.07

Satisfactory methods of blade fastening involve no problems unless allowable stresses in the blades are very materially higher than those in the blade carrying element.

Increased capacity without decrease of rotative speed or increase of stresses may be obtained by employing multiple low pressure stages. This well-known and popular expedient possesses the merit of permitting high-vacuum turbines to be built at speeds and capacities up to approximately the present limits of generator construction, without exceeding moderate diameters, blade lengths and stresses.

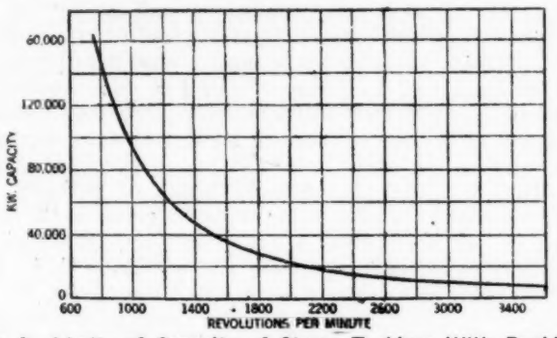


Fig. 3.—Limits of Capacity of Steam Turbines With Double-Flow Low-Pressure Stages.

Having steel blades of uniform cross-section stressed to 25,000 lbs. per sq. in. at base of blades at 20% overspeed and maximum efficiency at 80% of rating—250 lbs. steam pressure —200 deg. superheat—29-in. vacuum referred to a 30-in. barometer—with steam velocity through blades of 1225 ft. per sec. at a volume of 585 cu. ft. per lb.

Fig. 3 is a curve showing approximate maximum capacities at various speeds which are physically possible, employing double-flow construction without exceeding the limits of stresses previously given. For equal capacities employing single-flow construction the stresses would have to be doubled. The points marked (x) at 3600, 1800 and 1500 r.p.m. represent capacities which have already been built. This curve must not be interpreted as indicating suggested practicable present or ultimate limiting capacities of turbines, but merely as showing a physical relation between speed and capacity with given limiting stress values and operating conditions.

An important limit of size and capacity now being approached is that imposed by transportation facilities. Stationary elements may be readily sectionalized as required and assembled after shipment. Ways may be devised also for partial dismantling of rotor elements, although diameter will be one of the limiting factors, and this cannot be reduced beyond the point of omission of blading.

While the physical dimensions and capacities of turbines are being constantly increased it is essential that the reliability factor be not decreased. The employment of special materials and higher stresses does not usually permit increased capacity or efficiency without a corresponding increase in weight and cost unless reliability be compromised.

If, having given a satisfactory reliable design of a given capacity employing low stresses, it is proposed to transform it by modification of design and substitution of higher stresses into a unit of larger capacity, greater blade lengths and probably greater blade weights, operating at higher speeds and involving higher centrifugal forces will be necessary, in order to secure the required area. The rotor structure may possibly be shortened somewhat but unless its total weight is increased nearly in proportion to the increase in stored energy in the individual blade, the unbalanced effect or disturbance caused by one or more blades breaking (which must be recognized as an inevitable occurrence in any turbine) will be greater, imposing higher stresses in the rotor shaft, bearings and bearing supports, and a greater factor of strength

will be required to withstand these stresses. The greater blade weight and higher speed will also require increasing the mass of the casing in order to prevent the blades from permanently injuring and possibly breaking through it if they should fail. The endurance factor of a turbine when operating under imperfect or abnormal conditions will be higher in proportion to the ratio of stator mass to rotor mass and of rotor mass to blade mass. The incorporation in the design of a turbine of features which increase the endurance factor will appreciably increase its cost but will also (to a very much greater extent) increase its value to the user.

In the study of economic limits of turbines of large capacity, consideration must be given to the fact that as yet such units are not required in sufficient quantity to warrant equipping and operating shops for their exclusive manufacture and that they must, therefore, be produced by largely the same processes and equipment as are used for smaller sizes which are built in greater quantities. As sizes become larger, a greater proportion of special equipment and processes becomes necessary, resulting in increased rates of cost unless accompanied by very material increase in quantity of production. Under present conditions this economic limit of capacity agrees closely with the physical limit of 1500 r.p.m. units.

In the larger low-speed structures the physical proportions become such that using ordinary steel and cast iron, to which we are limited by the metallurgical art, the distortions due to temperature changes and elastic properties of the materials are such that increased clearances and bracing have to be employed in order to maintain equal reliability and rigidity to a degree which causes the cost per kilowatt for a given efficiency to increase with increasing capacity. Further development of the allied arts and increased demand for larger units will tend to reduce the influence of this limitation factor.

Another factor tending to limit capacity of single units is the generating capacity loss resulting from suspension of service for inspection or repairs. For example, if a 30,000-kw. unit must be kept out of service ten days for a certain inspection or repair, a 60,000-kw. unit would have to be kept out probably 14 days for a similar purpose because of the greater time required to handle the larger structure. Therefore, if two 30,000-kw. units were used and each held out of service 10 days, the outage loss would be only five-sevenths as great as if a single 60,000-kw. unit were kept out 14 days.

In order to avoid the limitations or undesirable characteristics just referred to, a number of turbine units of capacities varying from 30,000 to 60,000 kw. have been built in which the turbines have been divided into two or three separate compounded elements, each driving its own generator and each capable of operating alone on high pressure steam in emergencies.

It is believed that units of this type will continue to be employed for the larger capacities because of the advantages not obtainable in single cylinder types which will justify their somewhat greater cost.

Turbine blading of the low-pressure stage should be designed so as not to throttle unduly the enormous volume of steam passing through it to the condenser. A turbine utilizing 28.5 ins. vacuum will be less expensive than one designed for 29 ins. The turbine chosen should be one able to utilize the best vacuum economically justified.

BRITISH COOKING AND HEATING APPARATUS USED IN WAR SERVICE.

A Total of 160,650 Pieces of Apparatus Aggregating 164,050 Kw. Used by British Army and Navy.

A. B. Gridley and A. H. Human in a report on electric power supply during the war contributed to the *Journal of the Institution of Electrical Engineers* (England) review various sections of electrical industry which contributed their part in providing requirements for the forces. In cooking and heating apparatus production there was great activity and much of the heating apparatus supplied to British Government departments was of a special nature. It is impossible even now, we are told, to give details that would be of the greatest interest because of "the confidential purpose of many of the processes adopted." We may give some data, however, affording some indication of the abnormal amount of work done for the particular purposes named.

There were provided for canteens, munition works, hospitals and national kitchens 4800 pieces of electrical cooking apparatus, aggregating 71,055 kw. capacity, which enabled 316,500 persons to be catered for daily. Electrical cooking apparatus supplied for use afloat consisted of 12,750 pieces, aggregating 27,750 kw., serving 63,000 persons daily. There were produced 55,500 heaters for gun mountings to prevent guns from jambing or freezing when in use in airplanes, aggregating 1020 kw. Some 24,000 pieces of apparatus (12,000 kw.) were made in the form of heaters for airplane engines to prevent freezing when standing awaiting orders. In addition, 39,600 pieces of auxiliary plant or apparatus, aggregating approximately 52,500 kw., were used in connection with the heating of oil for furnaces, primers for airplane engines, smoke screens, decoys, metal baths, muffles and crucibles, branders, glue pots, soldering irons, special heaters for explosive works, band heaters for shrinking bands onto shells, wood-seasoning ovens for seaplane work, armature dryers, airmen's suits, resin boilers, radiators and heaters, immersion heaters, copper circulator heaters for seaplane engines. The foregoing figures total out at 160,650 pieces of apparatus with a total capacity of 164,050 kw.

The material used was almost wholly of British manufacture, with the exception of regulation switches and, to a small extent, the wire used for heating, such as Nichrome. In the earlier part of the war the importation of Hart switches and Nichrome and Nichrome-2 from America was permitted, but later on British manufacturers supplied a good deal of the heating wire, and the import of Nichrome was prohibited. The type of element employed afloat differed from that employed on land. In the former case mica was almost universally used, and in the latter case fireclay. There was some slight difference in the method of construction, but the main feature in each case was similar.

Among a great deal of information respecting manufacturing operations in the United Kingdom during the war, Messrs. Gridley and Human give the following approximate particulars of the annual rate of production of electrical equipment during the latter half of the war period:

Generating apparatus	400,000 kw. per annum
Motors	600,000 kw. per annum
Transformers	500,000 kw. per annum
Converting apparatus	110,000 kw. per annum

Value of Statistics in Central-Station Operation

Manifold Uses of Statistical Data — How They Should Be Used—Methods of Organizing and Maintaining the Work of Compiling Essential Statistics for the Central Station

By EDWIN J. FOWLER

Statistician, Commonwealth Edison Co., Chicago.

FINANCIAL reports from the accounting department of a central-station company are usually shown only in dollars and cents. Statistical reports, using as a basis the dollars-and-cents figures from the accounting department and the kilowatt-hours, number of meters, number of customers and other unit figures, as obtained from the operating and engineering departments, consolidate these, showing figures on a per-unit, a percentage and perhaps on a graphical basis. In other words, statistics connect up the engineering side of the business with the accounting and financial sides.

Central-station statistics should deal, not only with what has happened, but should also estimate the probable demands and tendencies of the future. An enumeration of some of the principal uses that are made of statistics should give some idea of their real value in central-station operations:

Uses Made of Statistics.

(1) To compare operating expenses and other operating results and also construction costs, in order to know where and how the best results are being obtained and in order to follow up operating forces and instill some rivalry and pride in results.

(2) Statistics are absolutely essential in case of rate revision, either voluntary or taken up by the Public Utilities Commission or local regulating body, and in case of other investigations by the authorities; they are necessary in connection with the questions submitted by the government census officers.

(3) As a basis for estimates in advance of the probable maximum load, in order to determine how much additional capacity should be ordered for the coming year and as a basis for future fuel requirements.

(4) Load diagrams are considered necessary and are used regularly by those in direct charge of operating the distribution system.

(5) Load diagrams and statistics are also furnished daily and used regularly by the large railway customers of the Commonwealth Edison Co. in operating their extensive systems of substations and in an effort to hold their maximum demands within bounds, their primary charge per kilowatt being based on the maximum demand.

(6) To supply bond houses and bond salesmen facts regarding the business that are very useful, if not essential, as an aid in selling securities.

(7) Some of our statistics have been very useful for advertising purposes. Such advertisements have been used in the newspapers, in the street cars, in the financial magazines and publications, and by the contract department.

(8) Detailed statistics are usually necessary whenever a bonus or commission system of paying employes, such as solicitors, meter readers and billing clerks, is in use.

(9) Statistics are the foundation on which the studies of diversity-factor have been made in recent years. These studies have disclosed the great importance of this factor in the central-station business. This knowledge, heretofore so little understood or appreciated, has suggested the advisability of and pointed out the way to the making of rates which have materially helped in the development of a large industrial load and income.

(10) Statistics have been helpful, perhaps necessary, in many other ways in connection with rate making. For instance, in connection with street and interurban railway contracts, statistics reveal the relation between the maxima of various periods of time—half-hour, one hour or average of several hours—also they reveal what rate each class of business should pay from a cost standpoint and many times avoid the making of rates which would be unprofitable.

(11) The investment budget and property records in connection with fire insurance are reports which are usually and appropriately kept by the statistical department. As to their value, probably mention of them is all that is necessary.

(12) Customers' statistics, showing the load characteristics of all kinds of industrial or wholesale customers and of retail power customers, and showing the average bills and average rates earned by various classes of business served on retail schedules, have proven of great value.

Examples of Graphic Statistics.

For instance, there is a great deal to be gained from the statistics given graphically in the accompanying illustrations.

Fig. 1 gives the sources of the earnings of the Commonwealth Edison Co. It shows that the receipts from wholesale light and power customers increased nearly four times in five years. It also shows that the economic advantage arising from the diversity of different classes of demand in the community is being utilized by the development of not only retail electricity supply but also wholesale and railway electricity supply. The wholesale power load has increased from 65,450 hp. in 1913 to 110,200 hp. in 1916.

Fig. 2 shows the reduction in rates of two typical wholesale customers, each having a maximum load of 75 hp., one using the equivalent of his maximum six hours a day and the other twelve hours a day. These reductions in rates have been made in spite of the advancing cost of labor and fuel. The last reduction

shown, in 1916, reduced the bills of wholesale customers $216,000 per annum.

Fig. 3 is a diagram showing the relative growth in investment and in electricity sold during the years 1896 to 1915.

Who Should Use Statistics and How Statistics Should Be Used.

The large companies do much of the pioneer work along statistical lines and work out many of the reports and much of the data on which changes in policy in the various engineering, operating or commercial branches of the business are based. Some smaller companies not having statistical organizations to work out their own problems often adopt the policies of the larger companies without knowing all the facts regarding their own business. Assuming that what is correct for one is correct for another, the smaller companies sometimes make expensive mistakes.

We have reached the time when there are relatively few companies whose operations are restricted to the corporate limits of any single village or small town. A large proportion of the former small companies have enlarged their operations and supply adjacent communities or have been absorbed in one of the group utility companies which operate over a considerable territory. Outside of a few remaining companies which operate in a single small community, electric lighting companies cannot afford to be without a distinct statistical organization, even though it consists of only one man of the right type devoting his entire time to the work. The larger and more complicated or varied the business or organization the greater the necessity for statistics and the greater their value.

A comparison of costs and other operating results as presented in the form of statistical reports usually results, after analysis and investigation, in uncovering certain definite causes for any differences that may exist. Usually these causes cannot be altered or changed, but in some cases these comparisons bring to the attention of the operating head conditions or methods of operating which, upon more careful analysis, it is found can be improved, with resultant economies or better service.

Another point regarding the value of statistics is that after having prepared the statistics in proper form and on the right subject at the right time it is necessary to *study* and *use* them if any benefit is to be realized. This, of course, is self-evident, but the point is that the statistical man must not only be able to prepare statistics but he must also study them and be able to discover the important facts which are hidden herein and to recommend and bring to the attention of the higher officers such action as is advisable.

Organization for Statistical Work.

The statistical man should not be tied down to routine work, but at least a considerable part of his time should be free for special studies of the various phases of the business and in keeping informed on what is being done elsewhere, both within and outside of his own organization.

His work should partly consist in keeping the essential basic records on (a) analyzed expenses in dollars and cents (as obtained through the auditing department from a properly balanced classification of accounts); (b) the number of customers, the important divisions of earnings according to rate schedules, kilowatt-hours sold, and according to towns or territory, and (c) maximum output and kilowatt-hour

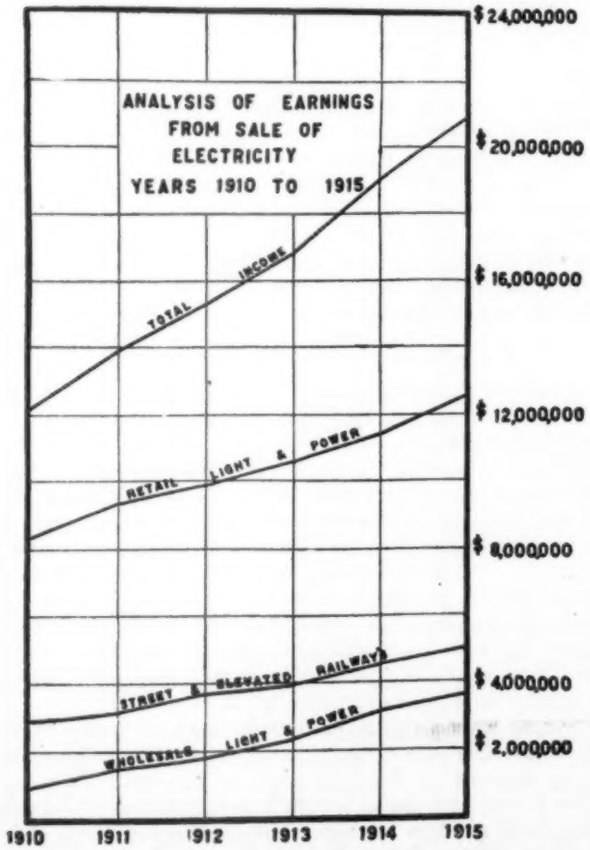


Fig. 1—Analysis of Earnings from Sale of Electricity.

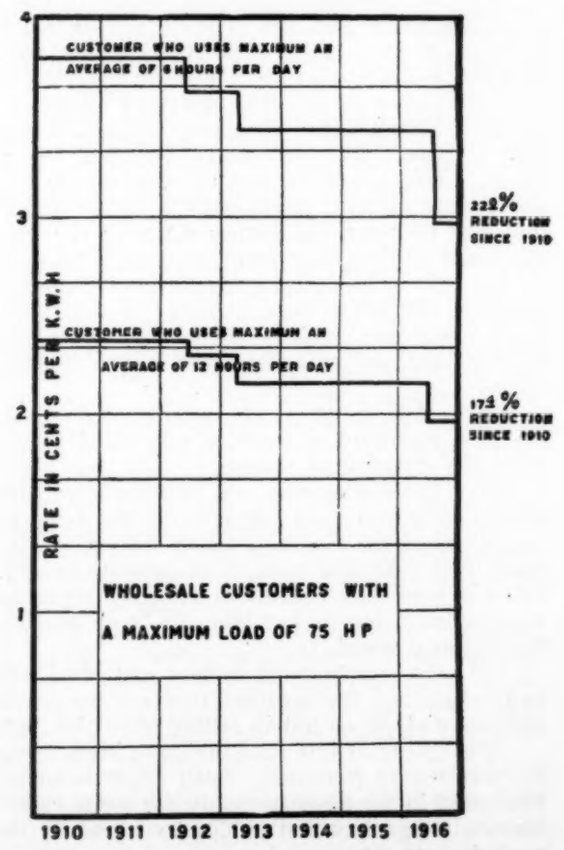


Fig. 2—Reduction in Rates to Wholesale Customers.

output of the stations and substations as obtained from the load records.

Another part of the statistical man's work should consist of obtaining such reports and comparisons from these basic statistics and from other sources, and in making investigations and special reports of any company matters which involve statistics to any extent.

The statistical department, to be at all successful, should have authority to go into other departments of the business and get any information or figures necessary. This information should be not only that easily available, but within reasonable limits the statistical department should have authority to have any special data or figures worked up by other departments. The statistical men should be independent and should have the privilege of reporting on any branch

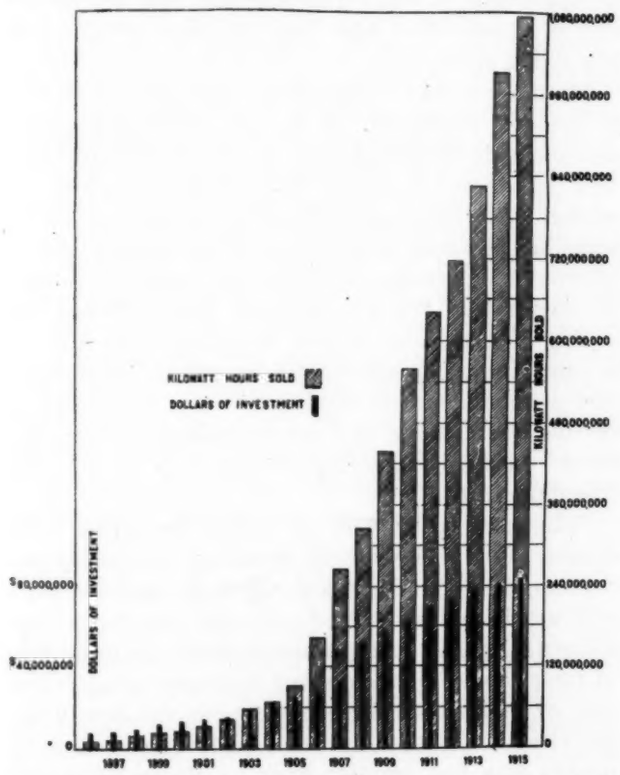


Fig. 3—Relative Growth in Investment and in Electricity Sold

of the business, even though the report may reflect in a way upon results that are being obtained in that branch. These reports should be made to the department interested and should be given enough circulation among the other higher officials so that the matter may receive general attention. This, of course, must not be in the spirit of censure, but in the spirit of educating and keeping the officials informed on what is developing and what is being accomplished, whether it is favorable or unfavorable. It goes without saying that the statistical department should be conducted on the highest plane of disinterested service for the good of the whole enterprise.

It is important to keep a record of only the essential statistics, which should be as simple as possible and usually without comparisons and without adding percentages or unit costs. Few printed forms are usually advisable. It is preferable in a great many cases to typewrite the forms once a year, filling in the data each month as the year progresses. These basic statistics are usually kept only in the statistical department and are available for drawing off any information requested and for making up special reports and special comparisons.

An occasional timely report made up specially and in complete form usually commands much more thorough and immediate attention than a regular periodical report on a printed form and costs very much less.

In the foregoing it is not meant that there should be no regular periodical reports on printed forms showing percentages and comparisons. Some are really essential, but in too many cases a regular periodical report is started and then, after a short period, it falls into disuse, although the making of it and the consequent expense go on indefinitely.

The statistician should not find it necessary to build up a large organization—that is, a large number of employes—as he will usually find that a large part of the detail reports and data he wants is already prepared by and in the hands of the various departments of the company.

The man in charge of the statistical work should either have had some engineering education or be scientifically inclined enough to grasp the underlying engineering principles involved in the business.

Conclusion.

To sum up, every company, no matter how small, has an accounting record in dollars and cents of expenses, income and investment, but if it is to get the best results a study of the dollars and cents alone is not sufficient. The accounting figures should be coordinated with the other statistical facts of the business and the small company as well as the large should realize a definite advantage by developing or bringing into their organization some statistical talent.

Statistics should not be kept a little in this department, a little in that department and a little somewhere else, and given minor consideration as a relatively unimportant clerical matter, but the statistical work of any organization should be independent of the auditing and financial work and should also be independent of the operating, engineering and construction side of the business. Although small in number of employes and in expense it should be recognized and respected and given the independence of a separate department reporting to one of the higher officers, if not to the president.

EDINBURGH POWER PLANT ORDERED IN SWITZERLAND.

The lowest three out of 16 tenders submitted to the Edinburgh (Scotland) municipality for three turbo-alternator sets for its new Portobello generating station were from Swiss manufacturers. The municipality, acting on the advice of its consulting engineer, Sir Alexander Kennedy, accept the tender of Brown, Boveri & Co., of Baden, at $533,090. The tender of the British firm of C. A. Parsons & Co. was $350,000 higher and, as the British Government desires reasonable preference to be shown to British products when required for public undertakings, the matter was referred to the Board of Trade, which did not consider that so high a difference should be paid in order to keep the work in England. The Board invited British bidders to reduce their prices, but they intimated that they were unable to do so.

The contract for the boiler-house equipment for Portobello station (six boilers, etc.) went to the Stirling Boiler Co., at $1,003,305.

Editorial Comment

Some Factors Affecting the Coal Problem

COAL production is not keeping pace with consumption, and every day that passes brings nearer the time when, unless the striking miners go back to work, the country will face a serious situation. The coal strike will ultimately be settled by compromise, why delay?

Coal has assumed a prominent place in our national life. It seems as if at most only a few consecutive months can pass without coal coming into the limelight. During the war the demand for coal brought about the fuelless days, cessation of industry in some cases and lightless nights. Last winter, although the war was over, the question of shortage and of high cost, kept the consumer in uncertainty and suspense. This winter the bituminous coal miners are on strike for radical changes in their working week and in their rate of pay. Today, little coal is being mined and a famine comes nearer with every day of delay.

The fact is that coal is the beginning and the end, the *alpha* and *omega*, of our national life. It is vital, it is expensive now. It will be vital tomorrow and in the far future—and probably more expensive. The question, therefore, before every coal user, and everyone is potentially and indirectly a user of coal, is how best to solve this coal problem—a problem of transportation, of labor and of consumption.

There is every reason to believe that railroad freight rates will increase directly the roads are given back to their owners, perhaps before that takes place. The cost of haulage is a considerable item in the cost of fuel. The cost of coal at the mine will also in all probability increase before long, making more efficient use of coal imperative. The question as to how best to accomplish this, a difficult problem embracing many aspects, is a pressing one. But in attacking it, it is well to tackle those matters that are most easily accomplished.

The clean coal ruling instigated and somewhat enforced by the Fuel Administration when coal was a factor in winning the war should not only continue in vogue, but should be prosecuted more stringently than ever. Coal is already too expensive for the nation to continue to pay for slate and dirt at the price of coal. Freight rates are already too high without paying for the movement of slate and stone dirt, something that is of no use and whose presence does considerable harm. One of the most urgent needs then toward a partial solution of the coal problem and incidentally for placing our railroads upon a proper basis, is to institute coal inspection stations at the mines, adopt a clean-coal policy and adhere to it religiously.

Another practice that came with the war that should be made permanent gradually and yet early is that of insisting upon the use of local coals. It is estimated that with the present annual rate of coal consumption within less than ten years present railroad facilities would be completely occupied with the the movement of coal. The zoning of coal is a matter that is closely allied with those of transportation and lower coal costs.

If it were made compulsory, gradually of course, to use coal contiguous to the place of consumption, new methods of burning coal would be developed and new fuels would come into usage. There is no scarcity of fuel. But the fuels we have become accustomed to using are becoming more and more inaccessible, necessitating going further way from the markets for them or deeper into the ground after them. When the zoning of coal comes, and it will come eventually—it is only a matter of time—lignites and peat, culm banks and other sources of combustible now despised will receive the attention and the utilization that they deserve. Coal prices and high freight costs are bringing that day nearer.

The coal strike will, of course, be settled ultimately. Coal will be mined again and production and consumption will keep pace. But the coal situation will not have been solved. It will only have been shelved. The use of coals near at hand, the utilization of fuels now left in the discard, insistence upon cleaner coal or at least a charge based upon the heat value and cleanness of coal, a method of storage so that the miners may find steadier work by reason of continuous output instead of seasonal output, are some of the most apparent and some of the most promising contributing factors to the permanent solution of the coal situation.

Sticking to Business

IN a recent article appearing in the ELECTRICAL REVIEW a statement was made by the author that no equipment of a certain variety was available that met all requirements as regards flexibility demanded by average central-station practice. In an almost consecutive issue appeared an article upon the same subject, this time the author being the president of a manufacturing company, in which it was pointed out that absolute flexibility of the apparatus under discussion was now existent, and that any central station had almost infinite choice when it came down to choosing its equipment.

Now the statements of these two men, the one an

operating engineer having a large transmission system under his charge, the other an engineer who has specialized upon one phase of central-station engineering, are contradictory.

The reason is that the operating engineer was not conversant with all apparatus upon the market, but had used and was still using, equipment manufactured by his own company to meet the needs as he and his associates understood them. He had not made himself conversant with apparatus already available, the evolution of which had occurred gradually through many years of practical trial and survival of fittest.

However, the point which it is desired to emphasize here is that practically every branch of engineering, or any commercial line of endeavor so far as that goes, is a matter of specialization. Producing a turbine is a specialized piece of work, as is also designing a voltmeter, producing a sewing machine or what not. The many who specialize in producing an oil switch or a phonograph will succeed better than one who attempts to make everything he uses; for the days are gone when everyone can produce the necessities of life.

The central station devoting its effort to producing and supplying electrical energy by means of equipment upon the market or produced by manufacturers already in the game, will do better than the utility that tries to make its own transformers, its own circuit-breakers, etc. Central-station supply, just as manufacturing, is a specialized job these days. And it can be done the better by not dabbling in other work, for failure only means that "service" suffers and that the public must pay for the experiment.

Regarding Large Turbine Units

ELSEWHERE in this issue will be found very frank statements by two of the engineers of two of the largest manufacturers of steam turbines. These statements deal with the limitations of turbine outputs, and physical and economic aspects of the situation.

However, regardless of whether large turbine units are reasonably reliable and the physical limitations as to maximum capacity, another question enters, and one which probably concerns more central stations than does the question of what is the largest size that can be made. That question is the most desirable capacity of the individual turbine to the total station capacity. This question is important because it affects not only reliability and the factor of safety of operation, but operating economy. For most central stations, all except perhaps the largest, the question is of more concern than knowing the largest turbine that can be manufactured with reasonable assurance that it will be capable of being placed in and out of service and subjected repeatedly to the other uncertainties of service without danger.

For example, 50,000-kw. turbines may prove very economical and the best choice for a station containing 300,000 or even 250,000 kw. in generating capacity. Units of such size in a station of such size permit of economical operation, which means operating the individual units at loads corresponding to their highest efficiency and at high load-factor, thereby resulting in low water rate of the individual units and a further low over-all fuel consumption by reducing to a minimum coal used for stand-by service, starting and running lightly, banked fires, etc. At the same time, if one unit should become *hors de combat*, a possibility that must always be taken into consideration with any form of prime mover or apparatus in general, not so much because of the machine itself but because of the ancillary apparatus, condenser, boiler, stoker, etc., the remaining units should be able to carry the load of the unit not available without creating undue difficulties.

Reduce the station capacity to 200,000 kw., still retaining 50,000 kw. turbines, and the loss of one unit immediately becomes a very much more serious matter. Going further still, suppose a station contains only two or even three units, and one fails. It is probably true, if not axiomatical, that the larger the central station the greater the dependence placed upon it for power supply. To what extent is it advisable to put all the eggs in one basket—to use an old expression—or in other words place reliance upon one machine where two machines would give higher factor of safety of reliability with little loss of economy of floor space and initial cost?

And then, again, the ability to obtain efficient operation depends very largely upon the load-factor of the station, the manipulation of individual machines according to load, or the co-ordination of machines to load so as to operate each unit at its best efficiency and highest load-factor. The fewer the units in a station the less the flexibility; thus while the larger the size of unit the higher the efficiency, the higher efficiency may be balanced and even counteracted by lower operating economy because of inefficient operation imposed by the fact that the size of the individual units have not been correctly co-ordinated to the station load as a whole.

It thus seems that for turbogenerators of about 35,000 kw. and above, or even for 25,000 kw. and above, decision as to the choice of capacity of unit devolves not only upon whether units of such size are reliable but as to what is the most desirable size for a given station of a given number of units for serving a given load. Higher efficiency is of little real value when it does not work for higher operating economy, which is the condition obtaining when units too large and too few are chosen for a given plant, because the turbines have not been adopted to conditions to be met.

In other words, the choice of capacity of a turbine devolves, eventually, upon operating conditions, since these embrace reliability, individual efficiency and the co-ordination of load and machines for operating at the highest over-all economy.

Current Events

Turbo Units Discussed—Power Economy Conference Completing Organization — House Heating Studied in Idaho

LIMITATIONS OF STEAM TURBINES AND TURBOGENERATORS DISCUSSED BEFORE THE A. I. E. E.

New York Meeting Given Up to Problem of Construction and Operation of Large Turbine Generating Units.

Three papers of interest to engineers connected with plants having large turbogenerators were presented at the New York meeting of the American Institute of Electrical Engineers on Nov. 14. The papers were prepared at the request of the Power Station Committee in an effort to ascertain what, if any, limitations exist that will affect the size of large turbines and generators. The papers are the result of more than two years of work by the committee, of which Philip Torchio is chairman, and by the authors, Eskil Berg, of the General Electric Co., and F. D. Newbury and J. F. Johnson, both of the Westinghouse Electric & Manufacturing Co.

Mr. Berg's paper was entitled "Present Limits of Speed and Power of Single-Shaft Curtis Turbines." Mr. Johnson's paper had the similar title, "Present Limits of Speed and Power of Single-Shaft Turbines." These two papers are abstracted at considerable length in another part of this issue.

Mr. Newbury's paper, which is entitled "Present Limits of Speed and Output of Single-Shaft Turbogenerators," pointed out that output is determined broadly by rotor or stator dimensions. With speeds of 1200 r.p.m. and lower, the stator is the limiting member, while with higher speeds, the rotor is the limiting member. The most effective rotor diameter is not necessarily the largest diameter. To obtain maximum output at a given speed the rotor proportions must be chosen properly to balance mechanical stresses, rotor ampere-turns, and flux. American design practice has established 400 ft. per sec., approximately 4½ m.p.h., as an upper limit of rotor peripheral speed. The maximum length of core is determined by such factors as ventilation, bearing temperatures, critical speeds and limits to weight imposed by forging and transportation facilities.

Mr. Newbury presented a figure showing present limits to kilovolt-ampere rating at speeds from 3600 to 900 r.p.m. These limiting values are given as indicating present boundaries to knowledge and experience, rather than as real physical or other limits that cannot be exceeded. Mechanical forces due to short-circuit current and damage caused by armature winding failures are no greater in the very large generators indicated by the figure than in present-day 20,000 and 30,000-kv-a. units. No opinion is expressed as to the wisdom of installing very large single-shaft units. If operating engineers desire units of 50,000 to 100,000 kw., there is no question but that such generators can be conservatively designed and constructed.

Several engineers engaged in the discussion. Philip Torchio gave a short review of the progress of turbogenerator construction in this country. He said that the rotor is the limiting factor for speeds larger than 1800 r. p. m., whereas the stator is the limiting factor for speeds less than 1800. The development of this kind of machinery is indicated by the fact that a unit installed by the New York Edison Co. in 1895 was of 300 hp. capacity. One installed recently in the identical station was of 50,000 hp. The first American units were of a few hundred horsepower, but their capacities had increased to 5000 in 1906, 20,000 in 1912, 30,000 in 1913, and the large installations now being installed. Probably two-thirds or three-quarters of all central-station generating units are turbine units. Central stations supply only one-sixth of the total power generated in the country, of which 93% is developed by steam and 7% by water. An enormous saving of fuel can be effected by installing more turbogenerators.

B. A. Behrend called attention to the limitations imposed on the design of large rotating parts on account of the liability of metal to succumb to fatigue. The mechanics of the rotating parts of turbogenerators is not the same as that of members subjected to static conditions only. Since the stresses in rotors are alternating in a manner that cannot be ascertained accurately, the ordinary rules of the mechanics of static bodies do not apply to the problems met in the design of generators. Designers are coming to realize that the lessons in mechanics learned at school are not solutions of the problems of today. The fatigue of metal is a controlling element in motor sizes. Nonductile material must be avoided because ductility is a criterion of the ability of material to resist crystallographic deterioration. A turbine disk should be sufficiently ductile to bend flat on itself without cracking. It is incorrect, probably, to say that the limitation of capacity lies in the turbine. Machines cannot be increased in size indefinitely.

W. L. R. Emmet, consulting engineer for the General Electric Co., agreed with Mr. Behrend that there is a limit to the capacity of machines. There is a demand for large units, but there is no reason for them. He did not agree with Mr. Behrend, however, about the uncertainty and magnitude of stresses in moving bodies. Inelastic armatures on elastic shafts tend to produce dead running. By weighting bodies that vibrate excessively, the vibrations can be eliminated. In a series of experiments conducted recently by Mr. Emmet in which several hard rubber disks were mounted on shafts and revolved rapidly, the vibrations occurred in only one disk. This was the thinnest one. Vibrations could not be set up in the other disks by any speed. This experiment indicates that heavy disks should be employed in turbine runners.

W. J. Foster, discussing Mr. Newbury's paper, said that the rotor is the limiting part of a machine. There is no necessity for the occurrence of large eddy currents. It is entirely possible to build a 90,000-kv-a.

machine running at 1200 r. p. m. The matter of temperature control can be effected more successfully by radial than by axial ventilation. One thing worth considering is the advantage of 50 cycles. The construction of 50-cycle machinery will improve the opportunities of American manufacturers in foreign markets.

Among those who took part in the discussion besides those already mentioned were F. Hodgkinson, C. A. Adams and Farley Osgood.

SPECIAL MEETING OF OHIO ELECTRIC LIGHT ASSOCIATION CALLED.

One-Day Meeting to Be Held at Dayton on Dec. 3—Association Finances, Safety Code and Orders of Fire Marshal to Be Considered.

The Executive Committee of the Ohio Electric Light Association has called a special meeting of representatives of member companies to be held at the Miami Hotel, Dayton, Ohio, on Dec. 3. Three special subjects are to be taken up, the first being a change in the constitution relative to the payment of dues by active members. At present these contribute only about $1530 annually. Additional revenue is obtained through advertising in the association's monthly. It is proposed to increase the dues of member companies so as to secure about $6000 annually and permit the work of the association to go on unhampered because of increased costs.

Another matter to come up is in regard to the National Electrical Safety Code, especially Part II dealing with outdoor line construction. The present revision of the code, it is feared by many central-station interests, will increase the cost of line construction very much and a committee that has been considering this subject will report at this meeting regarding steps to be taken to protect the electric utility companies.

A third subject is to discuss action relative to the recent order sent out by the fire marshal of Ohio, requiring inspection of all buildings before central-station companies supply service thereto; the order also calls for installation of inclosed service switches and main line cutouts. As it is regarded by the central stations as an extremely sweeping order that will cause hardship, especially to the smaller companies, the subject will be given thorough consideration to secure uniform action.

MEETING OF EXECUTIVE COMMITTEE, INTERNATIONAL POWER ECONOMY CONFERENCE.

Plans for Permanent Organization to Be Carried Out Immediately by Executive Secretary Bolles.

A meeting of the Executive Committee of the International Power Economy Conference was called by Chairman C. A. Tupper for Nov. 17 for the purpose of formulating a plan of permanent organization. The chairman read communications from the only two members absent, expressing regret that important business engagements prevented their being present. Each, however, expressed great interest in the work and desired to be kept advised of progress made. One member made reference to interviews which he had with several important business men with reference to the work of the Conference and stated that all were deeply interested and desired to take an active part in the work at the proper time. These letters outlined ideas of organization which were thoroughly discussed by the members present.

It was reported by one member that in talks he had had with several local unions of the stationary engineers at Cedar Rapids, Ia., Milwaukee, Wis., and Louisville, Ky., with reference to the work contemplated by the Conference, the members invariably endorsed the idea and offered co-operation toward its success.

It was the consensus that the first work should embrace the formulation and printing of a statement of the objects sought, which should also give a tentative constitution, clearly point out the aims of the Conference, the general ideas of procedure to reach the goal aimed at and explain the organization necessary to accomplish the desired result.

A campaign should then be started to secure not less than 100 contributing members and more, if possible, to finance the greater work which must follow if success is to be achieved.

The executive secretary was directed to proceed immediately with this work as the situation with regard to fuel is already bad with absolutely no indications that conditions are likely to improve, at least in the near future. The success of such organizations as the International Power Economy Conference usually depends upon a few of its members who are willing to contribute considerable time and hard work. We believe that the Conference is fortunate in having the service of Col. F. G. Bolles, late of the War Department Claims Board, Washington, D. C., as executive secretary. Colonel Bolles is eminently well qualified for this work. His past experience in the national field of power development with such concerns as Westinghouse Electric & Manufacturing Co., Bullock Electric Manufacturing Co., Allis-Chalmers Co. and the Bucyrus Co., gives to him a firm grasp of the problem and its importance as a national conservation movement. Add to this his knowledge of foreign economic conditions gained through six years' travel in 14 European countries, also his wide personal acquaintanceship, and his value to this movement must be recognized as a most important factor in its success.

All the signs of the times point clearly to the great necessity for an organization such as is proposed to back up and co-operate with the Fuel Administration and, when it no longer functions, to continue the splendid work done by it during the war.

NATIONAL CO-OPERATIVE CAMPAIGN FOR MORE ADEQUATE OUTLETS.

Electrical Manufacturers, Central Stations and Others Urged to Bring Value of Convenient Outlets to Attention of Public by Advertising and Other Means.

In various discussions that have taken place among electrical contractors, central-station interests, manufacturers and others respecting the value of providing more wall and floor outlets in the average residence or apartment, there has been a general consensus of opinion that such outlets should be much more numerous, as liberal provision thereof will not only make the use of electrical appliances more convenient but more general. It has been pointed out that to bring this about the public will need to be educated to the convenience value of such outlets and away from the common and inconvenient method of attaching appliances to lighting fixtures with the resultant multi-

plicity of dangling cords, poor appearance and frequent interference with the use of the fixtures for lighting. This practice has come about largely through the custom of manufacturers of appliances and socket devices advertising various utensils connected to fixtures, the impression created in the public mind being that such connections are good practice.

One of the aims of the newly organized Advertising and Publicity Service Bureau of the National Electric Light Association, as set forth in the ELECTRICAL REVIEW of Oct. 4, is to stimulate interest in more outlets and for this purpose a special branch of the Bureau, known as the More Service Outlets Division, was organized. During the week of Oct. 20-25 several divisions of the Bureau met in Chicago coincidently with the Illuminating Engineering Society, among these being the More Service Outlets Division. The various means for most effectively reaching the public on the matter of convenient outlets were freely discussed and the conclusion reached that electrical manufacturers could doubtless offer the most important aid. The principal recommendations made on this and related phases of the problem were as follows:

That this committee recommends that electrical manufacturers, in illustrating applications of their devices in advertising, show appliances connected with baseboard and chair-rail outlets rather than to lighting fixtures.

That steps be taken to induce manufacturers of portable lamps to show their lamps connected to outlets in their illustrations in advertising.

That it would be desirable for manufacturers of wire, wiring devices, etc., who do national advertising, to include in their copy an appeal to the public to use more outlets, and that such manufacturers who do no national publicity work, but carry on local newspaper advertising over the dealer's name, introduce the same argument into their copy.

That central stations be urged to have some one man in each company cultivate the acquaintance of architects in their territory, and familiarize them with the advantages of specifying more outlets in their building plans.

To recommend to central stations the desirability of frequently circularizing the public with direct-by-mail matter on the desirability of more outlets, and that the Society for Electrical Development be asked to consider the preparation of literature of this character.

That the committee notify all manufacturers of outlets, wire, wiring devices, etc., of the desirability of having their printed matter, posters, folders, cartoons, etc., contrast the convenient outlet with the inconvenient one.

The committee also recommended that its name be changed to the Adequate Outlets Committee, this name being more descriptive of its work.

WORK OF THE SIGNAL CORPS OF THE ARMY.

Colonel Carty Explains Some Hitherto Secret Achievements of the Corps—Code-Deciphering Machine.

At a luncheon of the New York Electrical League at the Hotel McAlpin, New York City, on Nov. 12, Col. J. J. Carty, officer of the Legion of Honor and vice-president of the American Telephone & Telegraph Co., made the principal address, which dealt with the accomplishments of the American Signal Corps during the World War. Colonel Carty related some interesting incidents which had come to his notice during his time in the service.

One of the matters referred to was the danger that the Atlantic cables would be cut by submarines. As a matter of fact, two cables, one leading to Newfoundland and one to the south of Europe were cut at a point near New York. The means taken to combat this possibility were the construction of powerful radio stations at various points on the French and American coasts, the latter being connected by wire with Washington.

Colonel Carty also spoke of the desire of high army officers to devise a means whereby messages could be sent by cable and telegraph in plain English, thus eliminating the loss of time and uncertainty involved in using a code. This problem was solved by a device which the colonel spoke of as a cipher machine. By means of this device a message coming in from the printer telegraph could be run through this machine and the message obtained in plain English. This machine was in use on the lines between Hoboken and Washington and on those from Washington to Newport News. Colonel Carty paid a very sincere compliment to those whose duty kept them on this side and stated that their work was absolutely indispensable to the combat troops.

ELECTRICAL EXPORTS FOR SEPTEMBER BELOW AVERAGE.

Large Increase Shown Over a Year Ago, But Decrease From Preceding Month.

Decreases of approximately 20% are shown in the total of electrical exports of the United States for last September as compared with August and with the average of the first nine months of this year. As compared with September of last year, however, there was a gain of about 19%. The total of the nine months ended Sept. 30 last was $68,439,204, compared with $43,757,716 for the corresponding period in 1918, and $39,977,642 for the similar period in 1917.

These facts are disclosed in the monthly summary of the foreign and domestic commerce of the United States for last September published by the Bureau of Foreign and Domestic Commerce, Washington, D. C. The following classified figures, obtained from the same source, give the detailed data for September compared with the corresponding month last year.

Articles.	September 1919.	September 1918.
Batteries	$ 442,588	$ 250,037
Carbons	72,816	125,956
Dynamos or generators	525,040	269,276
Fans	49,768	26,396
Heating and cooking apparatus	91,881	48,552
Insulated wire and cables	301,315	548,640
Interior wiring supplies, including fixtures	146,729	58,139
Lamps—		
Arc	374	4,141
Carbon filament	10,861	6,369
Metal filament	358,396	282,518
Magnetos, spark plugs, etc.	226,843	206,160
Meters and measuring instruments	208,496	100,301
Motors	733,891	589,905
Rheostats and controllers	38,326	12,993
Switches and accessories	339,188	162,049
Telegraph apparatus, including wireless.	31,262	42,289
Telephones	199,936	228,961
Transformers	153,508	392,026
All other	2,188,370	1,761,369
Total	$6,119,588	$5,146,077

The above figures do not include electric locomotives. During last September there were exported 11 of these locomotives valued at $502,200.

N. E. L. A. COMMITTEES ON ELECTRIFICATION AND RESOURCES OF NATION.

Two Committees to Undertake Important Studies for Next Annual Convention Organizing with Active Chairmen.

President R. H. Ballard of the National Electric Light Association reports that Frank M. Kerr, vice-president and general manager of the Montana Power Co., has accepted the chairmanship of the Committee on Steam Railroad Electrification. The Montana Power Co., of which Mr. Kerr is the operating executive, is now furnishing the power supply for the operation of 657 miles of track of the Chicago, Milwaukee & St. Paul Railroad in Montana and the Pacific Northwest, and consequently Mr. Kerr is in a position to speak with authority on the subject of railroad electrification from a practical standpoint. R. Beeuwkes, electrical engineer of the Chicago, Milwaukee & St. Paul Railroad, will act with Mr. Kerr on this committee, and the additional members will be from other power companies, manufacturers and banking institutions, so that every phase of this great subject will be intelligently handled in the report of the committee which will be submitted at the Pasadena, Cal., convention, May 18 to 21.

M. S. Sloan, president of the Brooklyn Edison Co., Brooklyn, N. Y., has accepted the appointment by President Ballard as chairman of the Committee on Electrical Resources of the Nation. Mr. Sloan is organizing a committee to handle this great subject representative of all branches of the industry. The committee's report to be presented at the next annual convention will be of inestimable value to the industry at large. It will be in the nature of a textbook of particular assistance to the small companies throughout the country. The present status of electrical development in the United States, both private and municipal, will be noted, and the comparisons, drawn between different sections of the country and between private and municipal operation, should prove to be very interesting.

IDAHO INVESTIGATION FINDS ELECTRIC HOUSE HEATING IMPRACTICABLE.

Public Utilities Commission Conducts Most Exhaustive Study of Practicability of Open-Air Heating From Hydroelectric Systems.

One of the most unique investigations ever conducted by a state utility commission was recently concluded in Idaho and its findings have just been made public. It was a study of the practicability of general house heating by electricity and remains the most thorough investigation of this subject yet undertaken. Hearings were held by the Public Utilities Commission of Idaho for nine days last December and a mass of expert testimony, data, charts, etc., presented which fills a large printed volume of 576 pages. Digest of this testimony and deliberation on the subject took many months; the final decision was entered on Oct. 17 and is now just off the printer's hands.

At various times articles had appeared in the Idaho newspapers calling attention to the abundant water powers of the state which were going to waste and which should be harnessed for heating homes throughout the state. The question of electrical development was also brought up in political campaigns and many speakers made such sweeping assertions relative to the possibility of using hydroelectric power that the public was liable to be misled and have hopes raised that could not be realized. In two districts in Idaho a certain amount of electric house heating had been carried out which gave the basis for this agitation. The Commission undertook this study so as to get the actual facts regarding the practicability of house heating in general.

It was generally conceded that it would not be practicable to use electricity generated by steam for house heating in competition with coal, because in the first case, there would be actually realized only about 13½% of the heat of the coal, while in using coal directly in the heating of the house from 40 to 50% of the heat is utilized. The common notion that hydroelectric energy is much cheaper than steam-electric energy is more or less a fallacy. In Idaho, hydroelectric energy is used almost exclusively.

For the basis of this study it was assumed that the average six-room house in the southern part of Idaho would require about seven tons of coal annually for heating and that this heating would be of an efficiency of about 50%; to obtain the equivalent heat electrically would take about 25,000 kw-hr. The average demand in such a house would be 9.3 kw., but to heat the house comfortably during the extremely cold weather would require much larger installation. This excess demand would in most instances be taken care of by some supplemental heat from stoves or furnaces. In 105 houses electrically heated in the city of Twin Falls all but six have provision for such supplemental heating during the very cold weather. The Idaho Power Co. serves a district with about 100,000 population or 20,000 homes. Allowing 25% for losses in transmission, distribution, etc., to heat these homes electrically would require an installation of 258,000 kw. The total installed capacity of all present hydroelectric plants in southern Idaho is about 75,000 kw. and it is estimated that it would take all of the water power feasible for development in the state to heat about 77,000 homes, which is much less than the present number of homes in the state. Similar studies in Spokane, Wash., and in Toronto, Ont., Canada, showed that an extraordinary capacity, greatly beyond the present hydroelectric development would be needed for house heating alone, and this would furnish a load only about seven months in the year, leaving an extremely large plant development idle during some five months.

To heat the average six-room house with seven tons of coal annually at $10 per ton costs $70 a year. The cost of electric heating would be, under the most favorable conditions at least four times greater and, by the testimony of Prof. H. V. Carpenter, this cost would be about $444 a year. Allowing for the fact that large additional installation would be required for proper heating, it is concluded that electric house heating would cost from six to nine times as much as coal in southern Idaho.

The favorable conditions under which electric house heating is carried on in cases where electric power is used for irrigation pumping during the summer, permit utilizing the capacity that otherwise would be idle in winter. The Minidoka government reclamation project now heats five towns at very low rates, averaging 66 cents per kw. per month during the heating season. These rates include practically no overhead expense and fixed charges and will be raised about 50%, effective next March, which will bring the cost to somewhat above that of coal for an equivalent amount of heat. Even under these conditions it has

been found that the heating and irrigation load overlap during the early spring and the heating is then discontinued.

It was shown in the testimony that the heating of 15,000 homes in the district of the Idaho Power Co. would save about 100,000 tons of coal annually, whereas a smaller amount of electrical energy would serve to electrify the entire system of one of the trunk-line railroads in Idaho with a resulting saving of about 1,000,000 tons of coal annually.

The findings and conclusions of the Commission are substantially as follows: "Having made an earnest effort to secure all the light possible on the subject . . . we find no grounds for holding out to the people of Idaho a reasonable hope that electricity will ever be used generally for house heating in our state, and we are forced to the conclusion that the use of electric energy for house heating in Idaho in competition with coal is neither feasible nor practicable and would be unprofitable to any producers who might undertake to furnish the service, and further, that so long as there remains a field for the use of electric energy as motive power, its use for house heating is extravagant and wasteful." These conclusions were reached by Commissioners A. L. Freehafer and George E. Erb. They were concurred in by Commissioner E. M. Sweeley, who was not a member of the Commission when the investigation was begun.

PRINCIPLES OF RADIO COMMUNICATION WITH ANTENNA AND COIL AERIALS.

An extensive research on radio transmission and reception with various types of aerials has been in progress at the Bureau of Standards, Washington, D. C. One of the most interesting questions at the present time is as to the relative advantages of the antenna, or usual type of elevated aerial, and the smaller coil aerial. This question is answered by the studies of the Bureau.

As a result of this work it is possible to determine by simple calculation the distance at which a given receiving aerial will receive signals from any transmitting aerial when the current in the transmitting aerial, its dimensions, and the distance between the stations are known. The small coil aerial has many advantages, but is usually not as powerful a transmitting and receiving device as the antenna type of aerial. It may, however, have so much lower resistance than the antenna that it is equal to it in transmitting and receiving value.

Our knowledge of electric waves has been very incomplete. The work referred to has assisted in clarifying some of our ideas so that the way the two types of aerial operate can be better understood. It is shown that a special type of antenna, consisting of two large metal plates, has certain advantages. The fundamental principles of design of radio aerials have been developed. The investigation has opened up a large and most interesting field for further research and progress in the utilization of radio waves.

GERMAN USE OF SUBSTITUTES IN ELECTRICAL WORK.

In the course of some references to the effects of the war upon the German electrical industry, A. B. Gridley and A. H. Human state in the *Journal of the Institution of Electrical Engineers* that the Allgemeine Elektricitäts Gesellschaft and the Siemens-Schuckert group were the first to substitute aluminum for copper wire in machine windings, but it was soon found that the high cost and the growing scarcity of this metal necessitated recourse to the use of zinc wire. At first this wire was not successful owing to its brittle nature, but ultimately a more elastic and serviceable form was produced and firms commenced to manufacture motors with zinc wires which served their purpose more or less satisfactorily. The machines thus constructed were very nearly twice the size of the old type, and iron commutators were used. Transformers with zinc windings were also made, and the A. E. G. built transformers of this type of 7500 kv-a. capacity, which proved satisfactory.

At a later date, reversion was made partly to aluminum windings, and only in exceptional cases was the use of copper permitted in the construction of electrical machines. Conductors were made of iron, aluminum and zinc wires, little copper being permitted for this purpose.

Substitutes for rubber were adopted for the insulation of wires, the most satisfactory being impregnated paper. Resistances, controller contacts, etc., were made of iron. Switches, lamp bases, etc., were made of sherardized sheet iron. Iron was mostly employed in high-tension apparatus, current-carrying parts—except contacts—being made of zinc. Meters made of iron and zinc were produced.

Messrs. Gridley and Human report that, "Despite the restrictions and great difficulties which hampered them, the German manufacturing firms were far from nonprogressive, and while there are some in England who still have misgivings about using units of 25,000 kw. capacity, the A. E. G. manufactured during the war a 7000-volt turbo-alternator of 60,000 kv-a. capacity, the turbine blading of which was made of steel, without nickel, worked out of the solid. A second and similar machine has recently been constructed."

CHANGE IN EDITORSHIP OF LONDON ELECTRICIAN.

On Oct. 31, W. R. Cooper was presented by his colleagues of Benn Brothers with a silver rose bowl and Weston portable milliammeter, upon his retiring from the editorial chair of the *Electrician*, of London, after a period of thirteen years. Mr. Cooper has decided to devote the whole of his time to his consulting practice, the growth of which renders it impossible for him to continue his editorial duties at the same time. Mr. Cooper was appointed editor of the *Electrician* in 1906, and under his editorship the journal has made considerable progress.

His place will be taken by F. H. Masters who was chief assistant editor at the outbreak of the war in 1914. Mr. Masters received his technical training at King's College, London, and Finsbury Technical College, under the late Prof. S. P. Thompson. He was afterwards engaged in substation work on the Central London Railway, and in the Electrical Engineers' Department of the British Government Dockyard, Chatham. He joined the "Electrician" staff in 1906, and was subsequently appointed chief assistant to the editor. During the war he was engaged on coast defense electric lighting work and on searchlights used against enemy aircraft. He contributed considerably to the development of these defenses, and did very useful work in the training of the men engaged upon them. Mr. Masters was awarded the O. B. E. and was twice mentioned in dispatches.

Commercial Practice

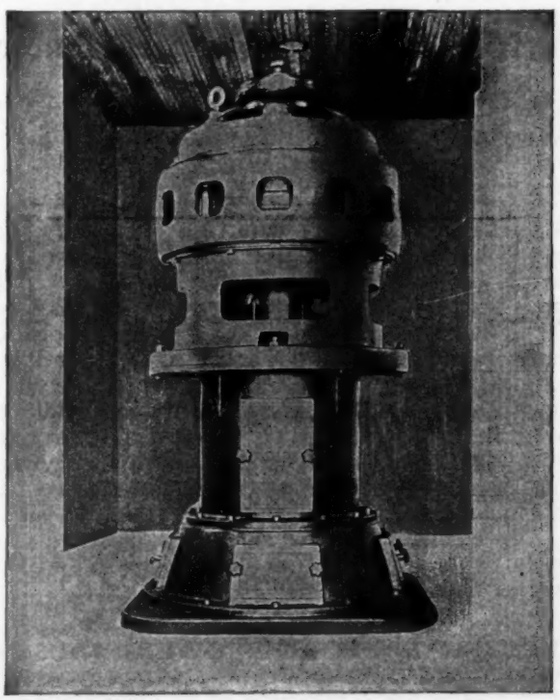
Electric Pumping Saves Money for City — Many Electric Elevators Being Installed — Dayton Flatiron Campaign

ELECTRIC PUMPING PROVES ECONOMICAL FOR CITY OF SAVANNAH.

First of Five Motor-Driven Centrifugal Water Pumps Shows Large Saving in First Cost and in Operation.

The city of Savannah, Ga., is now effecting a large saving every day on account of the installation of an electric motor-driven pump on an artesian well furnishing 4,000,000 gals. of water daily to the city. The plant from which the city formerly got its water supply cost $65 a day to pump a million gals. of water, while the new equipment pumps at the rate of $10 a million gals., or a saving of $55 for every million gals. pumped.

If the city decides to install electric pumps throughout, and the indications are that it will do so shortly, a saving of $57,500 a year will be effected in fuel and labor costs.



Centrifugal Water Pump Driven by 200-hp. Vertical Induction Motor at Savannah Water Works.

The artesian well is 519 ft. deep and was dug by the use of dynamite. A 24-in. casing was sunk to a depth of 110 ft. and from there to the bottom a 16-in. casing is used. The fact that this casing runs the full length of the well assures the city a supply of pure water. The pump is of the Layne & Bowler centrifugal type, is installed 100 ft. below the surface. It is driven by a 200-hp., two-phase, 60-cycle, 2200-volt, 1175-r. p. m., vertical induction motor which was built by the Westinghouse Electric & Manufacturing Co., and shipped to Savannah from the East Pittsburgh Works by express because of its urgent need by the city. Power for operation of the motor, is supplied to the city by the Savannah Electric Co.

Tests made on the water pumped from the well have proved its superiority over the water formerly pumped from the river station, and it is apparently much softer than any artesian water ever used in the city before. This softness is because it does not strike a strata of lime. The water is said to contain some sulphur, to lather fully, and to be unusually well adapted for all domestic as well as commercial uses.

A further evidence of the saving to be gained by the operation of the new outfit may be gained from the following figures submitted by the city officials. The original system with a capacity of 1,000,000 gals. was installed at an original cost of $750,000 and the operating cost amounted to $30 per million gals. To install the new system cost $10 a million gals., so that not only is there a large reduction in first cost, but the operating costs are reduced two-thirds. The pump was installed by P. D. Bowler, of the Layne & Bowler Corp., Memphis, Tenn., and the motor and control were supplied through W. C. Bryant & Co., Savannah.

The total number of wells completed, or for which contracts have been let is five, to be driven by motors of the following capacities: one 100-hp., two 200-hp., one 250-hp., and one 300-hp.

All of the motors are installed above ground on all these applications except one which is located under the street in a pit entirely inclosed and furnished with forced-draft ventilation.

The starting of the pump was the occasion of a large gathering of city officials, headed by Mayor Steward, and other prominent citizens. The mayor and other city officials express themselves as greatly pleased with the success which has already been attained in the operation of the new plant, and additional units will undoubtedly be installed at an early date.

ELECTRIC ELEVATORS IN DEMAND IN NEW YORK CITY.

Many Office Buildings Turn to Central-Station Service to Solve Problems of Elevator Operation.

One of the more recent elements of the tendency towards central-station electric supply in New York City is the increasing demand for electric elevators. The New York Edison Co. has compiled a list of 93 buildings that have done away with their old steam and hydraulic elevator equipment, changing over to electric, the estimated current consumption for this new elevator business being 2,000,000 kw-hrs. annually.

The cause for this renewed demand for electric elevators is two-fold. One is related to the building shortage, which is causing many old structures to be

altered to suit some special industrial need; generally one of the desired features is better elevator facilities.

Another type included in this list is the good grade of office buildings, which have previously been equipped with hydraulic elevators. In these instances, the reason for the abandonment of the hydraulic machinery has been the greatly increased cost of operating it, the expense having mounted in some cases 100% in the last three years. Frequently, too, this situation is closely related to the private plant question, for where high-pressure steam is required to maintain elevator service, there is a tendency to operate electric generating apparatus as well. About half of the 63 office buildings that have changed over to electric elevators have closed down their generating plants at the same time.

VERY SUCCESSFUL FLATIRON CAMPAIGN CONDUCTED IN DAYTON.

In One Month 1500 Electric Irons Were Placed in Service —Excellent Results in Neighboring Towns Also.

The Dayton Power & Light Co. recently conducted an iron sale campaign in the city of Dayton, Ohio, which was unusually successful. Other towns served in the company's system were also covered. In Dayton, with a population of 165,000, there were sold 1206 irons. In Wilmington, with a population of 5000, the sales reached 145, while in Piqua, with a 15,000 population, 130 irons were sold. In Xenia, with a population of 10,000, the sales were 100 irons. In addition to the irons sold, there were found over 300 irons on customers' premises that were not in use, due to their needing some slight repair. These irons were brought in, repaired and put back into service, making approximately 1500 additional irons on the lines in Dayton over what existed before the campaign was begun. About the same proportion of irons were repaired in the other territories.

In addition to making direct sale of irons, lists of those who were interested in other appliances were made and turned over to the contractors, and it resulted in a large increase in the sale of sewing-machine motors, sweepers, toasters, etc. The campaign began on July 1 and ended August 1. General Electric irons were sold at the full retail price of $6.50 and as a premium a folding ironing board was given. The customer paid 50 cents on the order and $1 per month with his light bill until paid.

Another novel feature of this campaign was that it was carried out by the pupils in the company's co-operative school for high-school students. These students made a house-to-house canvass, each carrying a card which gave the name, number of the house and report whether the occupants had an electric iron, whether they were using it regularly, whether it was giving entire satisfaction, and whether it was in need of repairs, etc. With this information the company was able to get a very valuable line-up on what the customers had and what they needed. No great amount of advertising was done in laying the groundwork for the campaign, as it was found that the house-to-house canvass was in a measure all the publicity needed.

After the campaign was over, in checking up with the dealers all the prospects that were handed in, it was reported that in practically every case the prospect was sold. The campaign was the most successful one the company ever conducted.

FALL SALES PROVE NOTEWORTHY IN BROOKLYN, N. Y.

Electric Washers and Vacuum Cleaners Sold to the Amount of $100,000 in Two Months.

Sales of the Brooklyn Edison Company resulted in 325 orders for washing machines during September and 1173 orders for vacuum cleaners during October, making a gross sale of over $100,000 for the two campaigns.

The washing machine offered in September was of standard make, with a special galvanized iron body substituted for copper, which allowed for a special price during the month of $129.75, with payments extending over 12 months. The October sale of vacuum cleaners offered a well-known cleaner, with a special "Brooklyn Edison" set of attachments, for $49.50, with partial payments of $4.50 on delivery and $5 monthly.

The advertising procedure was the same in both sales. Special return post-card announcements were sent to residential customers and two-column newspaper advertisements in preferred position were used periodically to keep up the interest. Demonstrations in all of the display rooms of the company were made each week and a selected list of customers were invited to attend. The two campaigns surpassed the corresponding sales in 1918 by 219 washers in September and 427 vacuum cleaners in October.

CENTRAL STATION BUYS POWER TO SUPPLY DEMAND.

Mobile Electric Co. Secures Additional Capacity by Co-operating with Shipbuilding Concern.

A transmission line by means of which the Mobile (Ala.) Electric Co. will secure electrical energy from the Chickasaw Shipbuilding Co. has been completed and placed in operation. As a result of power demands made upon the company during the past two years it had become necessary to provide additional capacity involving a new power house at an outlay of $1,000,000 or more capital. Instead, Manager T. K. Jackson saw the possibility of purchasing additional power from the shipbuilding company and an agreement was entered into whereby the Mobile company is to receive one-half of its energy demand from the shipbuilding company on a 3000-kw. peak load basis.

The company is now serving a power demand nearly twice as great as in 1916, chiefly due to shipbuilding activity.

ELECTRIC LIGHT AND POWER INDUSTRY COMMENDED BY BANKERS.

Investment Bankers' Association Says Central Station Deserves Confidence of Public.

The public utility securities committee of the Investment Bankers Association of America makes the following statement in its annual report relative to the electric light and power industry:

"It should not be difficult to educate the public to renewed and increasing confidence in an industry which has proven itself, even in the crisis of war, so stable, resourceful, resilient and productive, and which offers convincing promise for safe and remunerative employment of enormous additional capital."

Operating Practice

Underground Steam Lines — Electrolysis of Cables in St. Louis—Boiler Efficiency and Gas Survey — Power-Factor

METHOD OF INSTALLING UNDERGROUND STEAM LINES IN WISCONSIN.

Recommendations Made by State Engineering Department for Steam and Hot-Water Lines.

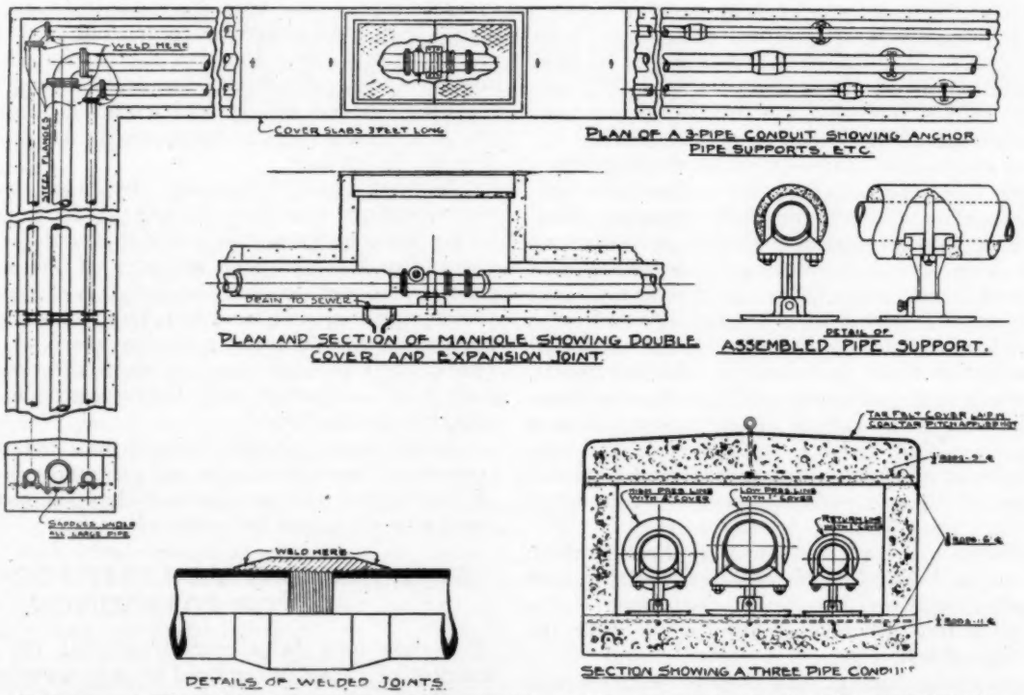
The state of Wisconsin has installations of almost every type of pipe conduit that has been devised and none of those as yet tried out has met the above requirements in a satisfactory manner. As a result of this experience the Department of Engineering worked out a method of installing such lines that has so far proven satisfactory, according to John C. White, state power plant engineer.

The conduit is made of concrete, of such size as may be required to accommodate the number of pipe lines and reinforced as necessary. The bottom slab is laid to grade for any section and is trowelled smooth. The sides are next poured and the work of installing the pipes may be started as soon as the forms may be safely removed. The cover slabs may be molded while the work of installing pipes is going on. These are generally made in 3-ft. lengths bedded in lime mortar. The top of the conduit is covered with a waterproof material such as tar felt before backfilling the trench.

Anchorage is so arranged that the pipes are permanently held in place at anchor points and expansion is taken either at the bends or by expansion joints. The supports are clamped to the pipes and move with them. They consist of a saddle clamp adapted to engage a round shoe which slides on the floor of the conduit as the pipes move under changes of temperature. Rollers are not used.

Insulation is applied as for exposed work and it is not subjected to mechanical injury nor to the action of water.

Drainage is provided for by making the conduit as nearly waterproof as possible and then conducting such water as does find its way into the conduit to drainage outlets at manholes or openings into the buildings. This water flows along the bottom of the conduit, each section of which is graded for that purpose, and by inspection at the drainage points the condition of the lines so far as water is concerned may be determined. Under-drains are not used.


WELD HERE
COVER SLABS 3 FEET LONG
PLAN OF A 3-PIPE CONDUIT SHOWING ANCHOR PIPE SUPPORTS, ETC
DRAIN TO SEWER
PLAN AND SECTION OF MANHOLE SHOWING DOUBLE COVER AND EXPANSION JOINT
DETAIL OF ASSEMBLED PIPE SUPPORT.
WELD HERE
DETAILS OF WELDED JOINTS
SECTION SHOWING A THREE PIPE CONDUIT

Underground Pipe Line Arrangements Recommended by Wisconsin State Engineering Department.

By arranging the pipes in a horizontal plane either line can be removed and replaced by disconnecting at anchors and connecting points and uncovering a sufficient length of the trench to permit withdrawal of the section. A line should be attached to the section before it is withdrawn for use in pulling in the new pipe.

Where steel or wrought iron pipe is used, the joints are made up with couplings and the backs of the couplings are then welded up until the section of the pipe that has been cut away by the threading process is built up to the original section of the pipe. The

joint is thus equal to the solid pipe in thickness and it is sealed against that form of leakage which is so persistent a cause of failure in the ordinary construction. Cast-iron flanged pipe may be used for low-pressure steam or hot-water lines. Lead joints cannot be used where temperatures change to an appreciable extent.

The accompanying illustrations clearly show the essential features of the method without further explanation. The first line was installed about two years ago for carrying high-pressure steam and so far has given no trouble whatsoever.

ELECTROLYSIS OF CONDUCTOR SHEATHS IN ST. LOUIS.

Use of Cambric Insulation Results in Time Lag Between Corrosion and Cable Failure.

The Bureau of Standards' investigation of electrolysis of underground cables in St. Louis has now practically been brought to a conclusion. The occasion of the work was a very serious case of corrosion of lead cable sheaths which appeared to be different in some respects from that ordinarily found. After extensive investigations regarding conditions both past and present under which these cables have been operated, and supplementary studies on the conditions under which lead is corroded, the conclusion has been reached that most of the burnouts now occurring are the result of electrolytic corrosion which occurred during the first few months after the cables were installed. The serious difficulty and large expense which are now being experienced are, therefore, the result of damage done several years ago. The long period which elapsed between the injury to the sheaths and the burning out of the cables is accounted for by the slowness with which moisture penetrated the varnished cambric insulation. As the insulation became moist, the dielectric losses increased and in many instances the immediate cause of failure of the cables has been overheating resulting from the large dielectric loss. A considerable number of failures were found to arise from surges of electric current resulting from other burnouts.

The peculiar appearance of the lead sheaths which gave rise to the belief that the failures were due to some hitherto unknown cause was found to be due to chemical action which had little to do with the failure of the cables.

In this case the damage has already occurred and can be repaired only by installation of new cables. Consequently, the Bureau's investigation of the problem has resulted in no saving to the company. The investigation has, however, been well worth while in that it has afforded a forcible object lesson of the importance of prompt attention to electrolysis conditions when new installations are made and it will, therefore, be of value in promoting careful consideration of electrolysis problems.

TEMPERATURE SURVEY AND GAS ANALYSIS IMPROVE BOILER EFFICIENCY.

Early in 1918 F. W. Dean, of the Emergency Fleet Corporation, made the request to the Bureau of Mines that it furnish the personnel and equipment to make determinations of the temperatures existing in the gases throughout the setting of a boiler. This was to be done in connection with the test of a boiler which the Corporation was conducting at Erie, Pa. O. P. Hood was in charge of the test and Henry Kreisinger, both of the Bureau of Mines, detailed to make the determination. The results obtained clearly indicated the necessity for further work on the problem of boiler efficiency, as was also forcibly brought out at the International Power Economy Conference held in Chicago recently.

The fact is not generally appreciated that sufficient air cannot be admitted through the fuel bed of a hand-fired furnace to provide for complete combustion. This fact is independent of the kind of fuel used or the rate at which air passes through it. Unless there are holes in the fuel bed through which the air can pass without coming in contact with the fuel, there is always 20 to 32% of combustible gases with no free oxygen to burn it. This important fact is generally overlooked, because in ordinary furnace practice there are so many holes in the fuel bed and so many leaks around the furnace doors and in the boiler setting that an excess of air commonly exists in the flue gases. In other words, two errors compensate for each other so that the existence of one is masked. The excess air which leaks into the furnace, however, does not usually serve the purpose of bringing about complete combustion of the fuel, because it is not properly mixed with the combustible gases, nor is it under control as to quantity. In other words, for proper combustion excess air should not leak through holes in the fuel bed, but should be introduced above the fuel bed in such a way as to bring about complete combustion of the gases.

Another point revealed by the temperature measurements was that changes in the design of the baffles were necessary in order to provide for proper absorption by the boiler surfaces of the heat in the gases. In boiler practice the design is commonly made from empirical data and not from exact determinations, so that the baffling of the gases to guide and retard their passage through the boiler setting until their heat is absorbed with maximum efficiency is not properly accomplished.

As a result of the information obtained from temperature measurements and gas analyses the design of the boiler was so modified that six tons of coal were enabled to do the work of seven.

USUAL ECONOMICAL LIMIT FOR POWER-FACTOR CORRECTION.

It has long been recognized that the additional amount of capacity required of a synchronous motor, to effect a given percentage increase of power-factor in the neighborhood of 100%, is several times that which would obtain at, say 60%. And this fact becomes more and more conspicuous as the power-factor comes nearer to unity or 100%.

While the lower the power-factor the more injurious the effect upon voltage regulation, investment, etc., it is also a fact that as the power-factor approaches toward unity the investment in corrective apparatus—a synchronous motor, for example—becomes so high that it does not pay to improve power-factor above a certain limit. In general, it may be stated it is usually not economical to correct above 90% and in most cases not beyond 85%. The chief reason for this is that most generators are able to maintain voltage sufficiently well at 90% power-factor and to release the 10% of generator capacity between 90 and 100% power-factor would require, on the part of the synchronous motor, about 40% of the capacity of the generator.

Contracting-Construction

Factory Lighting and the Contractors—New Construction Rules in Ohio—Connections Between Buildings Discussed

CO-OPERATION IN SELLING GOOD INDUSTRIAL LIGHTING.

Part That Contractors Can Play in Improving Lighting Conditions in Existing Factories and Planning for Good Lighting in New Factories.

Realizing that managers of industrial plants, as a general rule, have little knowledge of what constitutes good lighting and of increased production that results from it, the Committee on Illumination of the Ohio Electric Light Association has been conducting an investigation leading to methods for improving industrial lighting in that state. It is apparent that the electrical contractor is one of the most important factors in promoting good industrial lighting in existing plants as well as those under construction, and the following comments of the committee, which apply equally well to contractors in other states, should be well taken.

There seems to be a general appreciation on the part of the electrical industry that the industrial lighting field could profitably be given more attention. In this connection it is conceded that local electrical contractors must take a more active part in this work if it is to be very effective. It is obviously impossible for the contractor to undertake to bring existing lighting installations up to the high standards recognized today unless he pays particular attention to new aspects of the industrial lighting problem. It would seem, therefore, that the first step in any program that can be undertaken jointly by the contractors and central stations to encourage higher standards of industrial lighting would be for each contractor interested to delegate some one individual in his organization to make a special study of the subject and to acquaint himself with the latest lighting practice so that he can cooperate in selling industrial lighting.

While the work of laying out the lighting installation in existing plants according to the latest practice will fall in most cases upon the local electrical contractors, there is no question but that the central-station representative can approach a prospect for improved industrial lighting to better advantage than can a representative from an electrical contractor or manufacturer of lighting equipment. It would seem, therefore, that in the general plan of improving industrial lighting conditions the central station could undertake to make the initial call on its industrial customers with a view of discussing with the plant executive the general questions relating to the lighting service it is rendering the plants and to try to interest the plant managements in the value of good lighting to such an extent that they are willing to go into the question in detail. When the prospect is brought into this frame of mind he could be referred to local electrical contractors who are thoroughly conversant with what good industrial lighting work is and they could follow up the lead.

Other plans will have to be made, for the time being, to take care of lighting installations in buildings now in the process of construction, in which lighting layouts are made by construction engineers. However, buildings which will be put up next year and the years to follow will in most cases be occupied by industries now operating in old buildings and, if the managements of these industries really have been impressed with the value of lighting their plants properly, this will automatically insure good lighting in their new buildings.

OHIO FIRE MARSHAL REQUIRES INSPECTION OF ELECTRICAL INSTALLATIONS.

No Service to Be Connected Unless Installation Complies with National Electrical Code—Inclosed Safety Switches and Cutout Cabinets Also Required.

Electrical contractors and central stations in Ohio are much interested in, if not alarmed by, a recent ruling of the fire marshal of Ohio. By an order that was supposed to become effective Oct. 15 it is required that before making connection for light or power service all central stations are to make or cause to be made satisfactory inspection of the wiring on the premises to ascertain whether it is properly installed according to the requirements of the National Electrical Code; no service connection must be made until it is found that any changes required have been made.

It also was ordered that main service switches must be of the inclosed safety type and installed so as to be readily accessible, an exception being made if the switch is mounted on a switchboard under competent supervision. All other knife switches used for light, heat or power circuits, other than those used on switchboards or inclosed panelboards, must also be of approved safety inclosed type if installed within 7 ft. of the floor or elevated platforms. A further requirement of the order is that all automatic cutouts within 7 ft. of the floor or elevated platforms and in the vicinity of easily ignitable material must be inclosed in approved metal cabinets.

Furthermore, the order also provides that all alternating-current motors above 5 hp. must have approved starting devices; starters for direct-current motors must be equipped with no-voltage release attachment, and all motor starters having exposed contacts must be installed and placed so that accidental contact by person is reduced to a minimum.

No provision is made in the order for putting it into effect, since the state has no inspection department especially delegated for this purpose, and there are only a few municipal electrical inspection departments in the state.

This order is regarded as so important by Ohio central stations that it is one of the questions to be discussed at a special meeting of the Ohio Electric Light Association on Dec. 3.

Discussion of Code Rule on Inter-building Connections

Uncertainty of Intent of Rule 17*d*—Analysis of the Rule and Suggested Changes—Paper Presented to National Association of Electrical Inspectors

By H. S. WYNKOOP

THE existence of Rule 17*d* of the National Electrical Code is due to a desire to limit the indiscriminate ramification of electric light and power systems throughout private properties, where supervision and maintenance of equipment are difficult and where accidents may readily happen to workmen engaged in altering or tearing down buildings, through the unsuspected presence of these conductors. Municipal authorities, furthermore, object to the use of house mains instead of street mains because the former evade franchise charges. Neither the rule nor the reasons for its existence seem to be well understood, even by those who have most occasion to use it.

It is contended by some that the rule does not clearly convey its intent, by others that it does not say what its framers supposed it to say, and by still others that its requirements, under whatever interpretation may be assigned to them, are unreasonably severe, and perhaps altogether unnecessary. Rule 17*d* reads as follows:

> "No underground service from a subway to a building, and no service from a private generating plant, shall supply more than one building, except by special permission, unless the conductors are properly protected by fuses and are carried outside all the buildings but the one served. Conductors in conduit or duct under two inches of concrete under a building, or buried back of two inches of concrete or brick within a wall, are considered as lying outside of the building. These requirements do not apply to factory yards and factory buildings under single occupancy or management."

There are two corrections which it is generally agreed should be applied to the rule: (1) It should include overhead services and (2) "*one* served" should read "*ones* served."

An explicit definition of the term "factory yard" is difficult to find. Perhaps the following will suffice: "A factory yard is any group of buildings, with no street intervening, which is under one ownership or occupancy and which provides physical access between buildings without the necessity of going upon the street." A dwelling and its private garage on one plot would constitute a "factory yard," as would a group of buildings comprising a brewery. But if some of the brewery buildings were located across the street from the main group the former would be classed as one "factory yard" and the latter as another. This interpretation may not be necessary or even desirable in the smaller communities but in the larger cities it is of considerable importance.

Having divested Rule 17*d* of its non-essentials, the first difficulty in interpretation which we encounter lies in the word "building." What is a "building?" The Electrical Code of the City of New York says that a building is "any edifice, structure or enclosure, whether roofed or unroofed." I have been at considerable pains to call for definitions from electrical authorities throughout the country. Few replies have been received; and I cannot evade the conviction there exists a lack of appreciation of the importance of the subject and in some cases an inability to phrase an answer. These are all the definitions that have come to me:

> "A building, in the case of apartments in a row, is that part which is separated from other parts by standard fire walls; that is, 12-in. walls and double fire doors."
>
> "A building is a structure originally erected as one building by one owner and where the structural details are such as to plainly indicate this, and, further, where the building is so constructed that any one part of it could not be sold by itself. The same heating plant, ventilating system, janitor service or similar service would, as a general rule, indicate a 'building.' The fact that a building may be separated by partitions or even by solid fire walls does not alter the ruling of this department in regard to a structure being a 'Building'."
>
> "A building is a structure under one roof, the entire area of which is accessible from within."
>
> "A building is a property entirely separated from adjacent properties by fire walls or otherwise, and individually owned and controlled by a party or agent, as a business block which may contain a fire wall or other dividing member within its outer limits."
>
> "A building is that portion of a structure or succession of structures which is separated from every other portion by unpierced fire walls."

The last definition is the one employed in New York.

It will be observed that all these definitions convey more or less clearly the idea of detachment through non-intercommunication, showing most explicitly that all the authorities are generally in accord in the desire to limit the spreading of electric light and power systems throughout blocks, and are casting about for some happy phraseology which will properly describe the zones into which all the structures in the block are considered to be divided.

Some one has said that a row of buildings in a block is comparable to a pile of floors in a skyscraper which has been laid on its side, and that, if we allow risers to run unrestricted from basement to top floor, we should permit a horizontal main to run from the first building of the row straight through to the last building. The comparison is unfortunate; for in one case we have a number of floors not separated by unpierced fire barriers (and consequently, interaccessible) while in the other case each building is so separated from its neighbor.

But we must not dwell too long on what a building is. In the fullness of time—probably within six months—we shall have the answer. Let us now consider the rule with a view to determining just what it calls for and in an effort to agree upon the end to be accomplished by this rule or by some better substitute for it.

Discussion of the Rule.

Rule 17*d* says, in effect, that you cannot feed through from one building to another, whether the first building has a company service or an isolated plant *unless the conductors are properly protected by fuses*. If, then, fuses are provided you can run feeders all through the block, but you must not enter any building except "the ones served."

Did the framers of the rule mean to say this? Is anyone willing to subscribe to such a broad permission, with all its resultant disadvantages and dangers? Subcommittees of the Electrical Committee of the National Fire Protection Association are now grappling with this problem and it is expected that definite recommendations for an amended rule will be considered at the meeting in March, 1920.

With one more comment we shall dismiss the rule as it now stands. The requirement of concrete or brick over the conduit is only a means of securing the equivalent of a line carried outside. A short-circuit in a street main would introduce no hazard into the building. A short-circuit in a house main laid in a brick wall would introduce no hazard. But a short-circuit in a main run through a basement might cause a very serious fire. The man who replaces fuses on a line leading to some other fellow's building usually sees to it that they shall not readily blow again. In brief, he is very apt to adopt the time-honored central-station practice of "burning off the ground." If we have concrete or brick over the conduit a reasonable protection against this has been provided.

The ideal condition would exist if an isolated plant never had to serve other than its own building and if the electric light company always could provide a separate service for each building. But in practice we find that the continually improving economy of the incandescent lamp releases generator capacity which can be used next door, that the lighting company cannot open a new pavement which has just been laid, that some influential industry on a rear street where there is no main must be supplied, and that some person who has no franchise sets up a block lighting plant and schemes in every devious manner to evade Rule 17*d*. Manifestly, the line must be drawn somewhere—but where?

It seems that we shall have to make the answer hinge upon inter-accessibility. We cannot use the one roof or structural idea, for a business may expand from a three-story building into a four-story building next door, and the occupant may cut doors between the two premises and run both places as one establishment—one building. We cannot base our ruling upon the occupancy, as the occupant may control a number of adjoining warehouses which he prefers to keep separated from each other by unpierced fire walls in order to reduce the insurance rate. Nor can we be governed by the ownership, as one individual may own an entire row of apartment houses, each absolutely separate from each other, and each constituting a separate building.

Fortunately, the analysis leaves us on firm ground. The lighting company does not desire to have connected to its system any equipment over which it cannot exercise at least supervisory control. If its service enters a building it has such control. But if the feed is taken from another building instead of from a street main, the company may be unable to enter the premises with which it has no direct relation. This is a dangerous situation, for in one case at least, in the Middle West, the court has held the public utility company directly responsible for accidents occurring on equipment which it is supplying, on the theory that it is the company's duty to assure itself of the safety of these equipments. How such a theory would work out in a case where the company sold electricity in bulk to a customer who resold it at retail throughout the block, is hard to say.

Similarly, the electrician of an isolated plant prefers to serve only the equipment in his own building. Defects in the equipment next door blow his fuses and trip his circuit-breakers, keeping him continually on the jump. If he attempts to remove the cause of his troubles he is told to stay in his own building and run his plant. This is particularly exasperating to the man whose own equipment is always kept in first-class condition, and he sometimes yields to the temptation to "burn it off."

Municipal authorities, too, consider that it is well to limit the supply to the building directly served, as this offers the simplest control. In giving approvals of equipment, in listing defects, in disconnecting dangerous work, in controlling franchise rights, in setting under way legal action, the one-building-on-one-service plan establishes clean-cut conditions, which do not otherwise prevail.

Suggested Changes.

Undoubtedly it will be agreed, after this brief review of the situation, that Rule 17*d* should be rephrased in some manner which will satisfy the following principles:

(1) Only such equipment may be connected to a service as can be considered to be directly under the control, through ready access, of agents of the serving party—whether lighting company or isolated plant.

(2) Where it is necessary to serve a second building from a building having a service, instead of from a direct street main, the construction must be such as to give the equivalent in safety and control of that which would be provided by a direct service.

(3) No electrical energy shall be carried into a building which is not used in said building.

(4) The equivalent of a street main and a direct service may sometimes be secured by the use of conduit or duct covered by concrete or brick, where it is absolutely necessary to feed through from one building to another.

(5) A service which is split before entering a building and is carried along the exterior face of several buildings, either overhead or underground, does not come within the scope of this discussion.

(6) It is probably impracticable, at least in our larger cities to adhere absolutely to the rule of one-building-on-one-service.

I trust that I have succeeded in laying before you fairly one of our big-town problems. Do not, however, assume that the smaller cities are not concerned. Every electrical inspector, every lighting company, and every franchise-granting authority should be interested in amending Rule 17*d* so the laxness and uncertainty of the present rule will be eliminated. And to that end I look to the National Association of Electrical Inspectors and its friends to present that helpful discussion without which we cannot progress.

New Appliances

Steel Reflectors with Luminous Glass Tops — Portable Flood Lamp—Safety Motor Switch—Marine Lighting Set

Ivanhoe-Regent Works Announces Metal Reflectors with Glass Tops.

A decidedly new development in reflectors for industrial service, of both dome and bowl types, is announced by the Ivanhoe-Regent Works of General Electric Co., Cleveland, Ohio. The new reflectors afford all the advantages of porcelain-enameled reflectors while permitting the distribution of some light above the units, thus relieving the gloomy appearance often prevailing when no light is directed above the level of the lamps.

The metal part of the reflector is of one compact piece, the form and the heel being connected by legs securely welded to each part. The contour of the metal part of the dome type approximates that of the Ivanhoe RLM standard reflectors of the same size.

Dome Type Metal Reflector with Glass Top to Permit Some Light to Reach Ceiling and Upper Walls.

Bowl Type Metal Reflector with Glass Top to Remove the Customary Gloomy Contrast of Dark Upper Parts of Rooms with Bright Working Areas.

The glass top is in little danger of being broken as it is small and well protected. Well diffused light reaches the space above the lighting units through a small section of opal glass of good quality firmly fitted in the top of the reflector. This light gives the room a more cheerful appearance and assures better diffused lighting because of the light reflected from the upper part of the room, softening shadows and reducing reflected glare.

Possibility of eye strain because of the sharp contrast between the dark region above the lighting units and the bright region below them is eliminated.

Ivanhoe glass-top reflectors are of special advantage, both in rooms with light or dark walls and ceilings, because of the more uniform distribution of light over walls and ceilings than is possible with reflectors which permit no light to pass upward. The efficiency is not seriously affected because much of the light which reaches the upper parts of the room is thence reflected downward.

Benjamin Luminous-Top Reflector With Opal-Glass Hood.

It is known that the great contrast between an unlighted surface and an adjoining brightly illuminated one is very trying to the eyes. Formerly illuminating engineers used to pride themselves on industrial lighting installations in which opaque reflectors were used to cut off *all* of the light that otherwise would strike the ceilings and upper parts of the walls. The result was a high efficiency of utilization because practically no light was *wasted* in the upper part of the room. Nowadays, however, it is realized that if a moderate amount of light does reach the ceiling and upper parts of the walls it is *not* wasted, for it reduces the great contrast between the intensively bright sources and highly illuminated working surfaces on one hand and the otherwise dark and gloomy ceilings on the other.

Benjamin Luminous-Top Reflector to Give Soft Light in Upper Part of Room and High-Efficiency Illumination on Working Plane.

This idea is being applied to certain enameled-steel reflectors made by the Benjamin Electric Manufacturing Co., Chicago. The neck or hood part of the reflector is made of opal glass, permitting a soft light to be projected to the upper part of the room. In factories with dark walls and ceilings, this unit through its luminous top diffuses a certain amount of light to the upper portions of the room, thus bringing out in detail the belting, pulleys, etc., occupying that space. The effective illumination of the area above the rim of the reflector also serves to increase the apparent height of the ceiling and thus produces a sense of greater freedom of action among the workmen. It also makes the room a more cheerful one by removing the gloomy and forbidding aspect of very dark ceilings.

In factories with white or light-colored walls and ceilings, this unit serves to increase the effectiveness of the illumination. Sharp contrasts are reduced and a better quality of illumination results. The light which otherwise would be lost in the recesses of the fixture is put to useful work. Where the walls and ceilings are light part of this light is reflected back upon the working plane and in this way increases the efficiency of the lighting system.

Benjamin luminous-top reflectors are built in the RLM standard dome shape and at present are made in the 14 and 16-in. sizes. The former is suitable for 100 and 150-watt Mazda type C lamps, whereas the larger size is suitable for 200-watt lamps. It is also possible to secure the opal glass hoods separately to allow for replacements of any broken parts, although the construction of the unit is such that the breakage should be very small.

Western Electric Portable Utility Light for Nearby Flood Lighting.

A new type of modified projector for highly localized lighting has recently been placed on the market by the Western Electric Co. This unit, which is to be known as the Western Electric portable utility light, is for use at close ranges where the light is to be located at distance not greater than 125 ft. of the object or surface to be illuminated.

With the light operating on a 100-ft. throw, a 100-ft. spread is obtained at an angle of 60°. The unit gives a smooth white light without serious gleam or glare. This is made possible by a new development—the hammered glass reflector. A 200-watt Mazda type C lamp is used. The unit is of especially rugged construction throughout and will withstand rough usage in service.

The hammered glass reflector is spring-suspended in a one-piece cast-iron housing. The housing is closed by a wire-glass front which is fitted into a recessed cast-iron ring. This forms a door which is hinged at the bottom and secured by a hand latch, thus affording easy access to the interior of the housing. The recessing in the ring makes the interior fully weatherproof.

This lighting unit can be furnished in either a black or gray weatherproof enamel finish. It is 19¼ ins. high and weighs approximately 30 lbs. This light weight makes the unit very easy to carry from place to place. The base is 9 ins. in diameter, giving the light stability when mounted on a flat horizontal surface. The unit can also be mounted on either vertical or flat surfaces such as walls, poles or roofs, by virtue of a heavy universal joint which

fastens the housing to the base. All adjustments can be made by hand; no tools are necessary.

The Western Electric portable utility light has a wide range of applications. In railroad work it can be used for lighting transfer tables, coaling stations, inspection pits, loading platforms, cranes, roundhouses and drawbridges. On marine work it can be used for lighting docks, dredges, slips, loading operations, canal locks, dry docks and pile drivers. Its industrial applications cover even a wider variety of uses, such as lighting shop yards, material yards, coal yards, well drilling, coal tipples, erecting shops, machine shops, tramways and inclines, conveyors and all kinds of emergency work.

Other uses will be found in illuminating playgrounds, skating rinks, signs, street corners, alleyways, swimming pools, monuments, flags, building fronts and construction work in general. In other words, it can be used for general flood lighting of nearby areas for which the ordinary floodlight projector gives too concentrated a beam.

New Westinghouse Safety Motor-Starting Switch.

A new type of motor-starting switch, which is low in first cost but provides complete protection to both the operator and the motor, has just been placed on the market by the Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa. It is known as the type WK-100 switch and is designed for connecting single or polyphase alternating-current motors of from 1 to 10 hp., 250 and 550 volts, directly to the line without the use of autotransformers or resistance.

All of the mechanism with the exception of the operating handle is inclosed with a steel box. The protective devices are easily accessible on opening a door in the cover; but this door can not be opened except when the switch is in the off position (nor can the switch be closed when the door is open) and all parts accessible are then dead. Therefore it is impossible to receive injury from contact with live parts when either operating the switch or making ordinary adjustments.

No-voltage protection to the motor is provided by a magnetic release which opens the switch automatically on a failure of voltage. Overload protection is provided by means of relays, resembling cartridge fuses in appearance, each of which contains a contact connected in series with the release magnet. Harmless momentary overloads have no effect on the relays, but as soon as the load on the motor becomes dangerous, the relay contacts open the magnet circuit and the switch automatically flies open. The relays then automatically reset themselves.

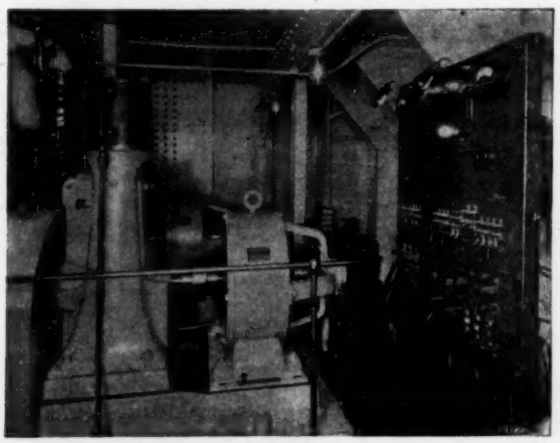
A New Marine Lighting Outfit.

A new line of engine-driven marine lighting generators, designed especially to insure reliability of operation, has recently been developed by the Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa. The sets range in size from 2 to 50 kw., and each consists of a steam engine coupled to a generator, the whole being mounted on a bedplate so as to form a compact unit. The 15-kw. size, shown in the illustration, is 6 ft. long, 3 ft. wide, 5 ft. high and weighs about 3300 lbs.

The engine used in these sets is manufactured by the Clarage Fan Co. It is of the single-cylinder, vertical inclosed V-type with automatic lubrication. It can be supplied for operation on steam pressures of from 80 to 250 lbs. and is suitable for either condensing or noncondensing service.

The generator, while in general of standard Westinghouse construction, is specially designed for marine service. The bearings are arranged so that perfect lubrication is assured regardless of the tossing of the vessel. The windings are specially insulated to protect them from salt and dampness. Metal parts subject to corrosion are made of noncorroding alloys. A special feature of these generators is their freedom from sparking at the commutator, even under heavy overloads. They are supplied for either 125 or 250 volts, direct current, and for either two or three-wire systems.

New Westinghouse Safety Inclosed Motor-Starting Switch With Switch Handle Locked in "Off" Position.



Two 15-kw. Westinghouse-Clarage Engine-Driven Lighting Generators on Steamer New Britton.

Inclosed Motor-Starting Switch in "Off" Position, Permitting Fuse Compartment to Be Opened.

Safety Motor-Starting Switch With Cover Entirely Removed, Which Can Be Done by an Authorized Person.

Trade Activities

Course in Production Methods Conducted for Crocker-Wheeler Foremen—Kallmerten & Warner Electric Formed

The C. Y. Engineering Co., Newark, N. J., of which C. W. Yerbury, a former Western Electric man, is manager, has taken over the business of the late C. McIntire, for many years a manufacturer of high-grade connectors and electrical specialties. The new firm aims to maintain the same high standard of production as was maintained by the C. McIntire Co.

Cooper Hewitt Electric Co., Hoboken, N. J., in order to secure more space for factory expansion, will remove several departments of the offices, on or about Dec. 1, to 95 River street. The departments affected are the executive, auditing, sales, purchasing and patent. The engineers' department will remain at the present location in the factory at Eighth and Grand streets.

Kallmerten & Warner Electric Co., 120 Lovell street, Charleston-Kanawha, W. Va., is the name of a recently incorporated concern, which will carry on a manufacturers' agency to sell and erect for mines such units as power plants, substations, ventilating fans, pumps, locomotives, etc. The company will also sell transformers, motors, small light plants, lamps, etc., and is equipping its shop with machinery to make armature coils, rewind and rebuild motors, armatures, field coils, transformers. The officers of the company are as follows: G. E. Warner, president and treasurer; O. W. Kallmerten, vice-president and general manager, and Ira W. Belcher, secretary.

General Electric Co., Schenectady, N. Y., has issued a handsome booklet entitled "The Electric Ship," which describes at some length the electric propulsion of the battleship *New Mexico*, which is considered one of the most remarkable engineering feats that has thus far been accomplished. How the electrical machinery looks, how it works, and why the electric drive is preferable to other forms of propulsion in terms understood by the average non-technical reader are described in Part I. Part II relates "what the experts say," and sets forth in their own words how America's leading experts regard electric ship propulsion and its economic and military advantages. A chapter on "The Electric Propulsion of Ships" is included by W. L. R. Emmet, consulting engineer of the General Electric Co., who in co-operation with the Bureau of Steam Engineering, U. S. Navy, developed electric drive for ships. Another chapter by Eskil Berg reviews the propelling equipment and operation of the *New Mexico*. The publication is profusely illustrated and contains considerable valuable data on the subject.

Webb Electric Furnace Corp. has established offices at 36 Church street, New York City, and has taken over the manufacture and sale of the furnace developed by the Old Dominion Iron & Steel Corp., Richmond, Va.

Jenkins & Knowles, with office and shop at 34 Wells street, Hartford, Conn., is the name of a new firm recently organized by H. E. Jenkins, Hartford, Conn., and Elmer J. Knowles, Worcester, Mass., which will specialize in power installation in factories and power plants. The firm will also do a general electrical business.

Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., has completed negotiations for the sale of its holdings in the British Westinghouse Manufacturing Co. for a consideration said to exceed $5,000,000. The company has completed arrangements for taking over the East Springfield plant of the New England Westinghouse Co., Springfield, Mass., and is planning to commence operation at once on the production of industrial motors and automobile starting and lighting systems. This plant will be operated as an additional unit to the East Pittsburgh works of the company and will afford employment for about 5000 persons.

Pyroelectric Instrument Co., Trenton, N. J., has issued an illustrated catalog entitled "Pyrovolter Type Instruments." The catalog which is perforated contains 40 pages of text and illustrations that indicate the details of the instruments, the different types and sizes, wiring diagrams, prices, the uses to which instruments can be placed, and other information. The Pyrovolter, which is an instrument designed, as the name implies, to indicate and measure high temperatures, was placed on the market in 1916. It is distinguishable from ordinary pyrometers in that the former measures potential and the latter current. In effect, the Pyrovolter principle provides a means of operating a deflection instrument on the potentiometer principle wherein the accuracy and permanency of the instrument depend basically upon a permanent magnet rather than upon a standard cell. Operation of the instrument is effected by balancing a potential drop against an unknown c. e. m. f. and then changing the connections of the instrument suddenly and observing the drop across an accurately adjusted fixed resistance. The connection is changed by turning a button. The instrument does not require the use of a standard cell nor does it have any temperature resistance coefficient. It is applicable to all situations in which high temperatures or minute temperature changes are sought.

Pierce Fuse Corp. of Canada, Ltd., Bridgeburg, Ont., capitalized at $250,000, was recently incorporated to manufacture renewable electric fuses. Officers of the company are: President, W. N. Pierce; vice-president, F. A. Myer, and secretary, B. C. Candee.

C. & P. Electric Works, Springfield, Mass., is sending out catalog No. 1 dealing with barrier panels, barrier cabinets, type "S" cabinets and steel boxes and cabinets. This catalog comprises 15 pages and contains illustrated descriptions of each product. The barrier cutouts are made of white glazed porcelain, with a patent upturned end which, when the cutouts are placed together, forms a barrier around the wiring gutter, and is one of the most convenient arrangements devised for panel construction. The feature of having a barrier made a part of the block reduces the number of parts and simplifies the operation of making up a panel. One of the principal advantages of the barrier panel is a substantial barrier between the busbars so that accidental short circuits are impossible. These products are of the N. E. C. standard and have been approved by the Underwriters' Laboratories.

Crocker-Wheeler Co., Ampere, N. J., has just inaugurated a plan of training for its foremen and other factory supervisors which is of considerable interest. A group of 62 men has been formed to pursue a three months' course in modern production methods, which comprises the study of specially prepared text units, the solution of problems relating to the units and the discussion of this material at six biweekly meetings held after hours in the plant. These meetings will provide an opportunity to bring home the application of the work to the special problems of the Crocker-Wheeler Co.'s production. At each meeting a lecture will be delivered by an experienced production man and the lectures will be followed by a round table discussion. Included in the group aside from the foremen are the superintendent and three assistant superintendents, and insurance is given that the meetings will be highly beneficial to the members of the class. The subjects to be studied are: How to promote team work in the shop; handling men in a way to increase production and promote harmony; how production should be organized; efficient purchasing, scheduling, routing, repairing, etc.: keeping down the overhead by stricter cost keeping and major problems of management. The course is under the direction of the Business Training Corp. of New York City which supplies the study material and the class instruction.

Current News

Weekly Record of Construction Activities—Conventions

EASTERN STATES.

Medford, Mass.—American Radio Research Corp. has completed arrangements for the erection of a new one and two-story radio building, about 60x120 ft. and 60x140 ft. on College avenue. Alonzo D. Wright, 40 State street, Boston, is architect.

New Britain, Conn.—Landers, Frary & Clark will erect a building 96x289 ft. to cost $200,000, and a three-story tempering building 40x68 ft.

Pawtucket, R. I.—Potter & Johnstone Machine Co. will build a two-story 63x72 ft. foundry addition and will alter buildings Nos. 1 and 2 at a cost of $60,000.

Pawtucket, R. I.—James M. Carpenter Tap & Die Works has recently broken ground for the construction of a one-story brick boiler plant on Newell avenue, about 20x30 ft. Willmarth-Mackillop, Inc., Freeman street, is the contractor.

Woonsocket, R. I.—Harvey Electric Co. has filed notice of organization to operate at 19 Sayles street. Harvey Lamy, 100 Arnold street, heads the company.

Bath, N. Y.—The question of issuing $35,000 municipal light bonds will be submitted to vote. Address town clerk.

Brooklyn, N. Y.—Metal Hose & Tubing Co., 253 Tillory street, has under advisement the erection of a $75,000 plant. Plans call for a three-story structure, 80x100 ft.

New York, N. Y.—Plans are under consideration by the Commission of Water Supply, Gas and Electricity for extensions and improvements in the electric street-lighting system in sections of 42nd street, including a rearrangement of lighting units in the vicinity of the Grand Central Terminal.

New York, N. Y.—In connection with the proposed construction of the large new motion picture studio building, about 200x600 ft. to be erected by the Selznick Picture Corp., 729 Seventh avenue, large quantities of electrical equipment will be required. The structure will be of reinforced concrete, and is estimated to cost $2,000,000. Contract for erection has been awarded to the Thompson-Starrett Co., 49 Wall street.

Rochester, N. Y.—Notice has been filed with the Secretary of State by the North East Electric Co., 348 Whitney street, of an increase in its capitalization from $1,000,000 to $3,000,000, for business expansion.

Schenectady, N. Y.—General Electric Co. is having plans prepared for the construction of a new five-story brick administration building about 54x219 ft. The structure will cost in excess of $350,000. Harris & Richards, Drexel building, Philadelphia, Pa., are architects.

Schenectady, N. Y.—Mica Insulator Co., Villa road, manufacturer of insulation specialties, has awarded contract for the construction of a one-story plant on Villa road. The structure is estimated to cost about $15,000 and will be used for increased output. Hanrahan Brothers, Wendell avenue, Schenectady, are the contractors.

Solsville, N. Y. — Public Service Commission has approved the application of the Solsville Electric Light & Power Co., operating in Solsville, Madison county, to construct an addition to its local electric plant, to provide for increased capacity. The company will also arrange for the acquirement of the local hydro-electric plant for operation.

Utica, N. Y.—Held Electric Co., manufacturer of electrical goods, etc., has filed notice with the Secretary of State of an increase in its capital from $5000 to $10,000, to provide for general business expansion.

Wayland, N. Y.—Wayland Light & Power Co., Inc., has been granted permission by the Public Service Commission to construct an addition to its electric plant at Wayland, and to construct and operate a new plant at Conesus, Livingston county, for local service, franchise for the latter having been granted by the municipal authorities recently.

Califon, N. J. — Califon Electric Light & Power Co. is making rapid progress on the construction of an additional power line from Hackettstown to Long Valley, to provide increased capacity. The company purchases its electric energy from the Hackettstown Electric Light & Power Co., Hackettstown.

Freehold, N. J.—Board of Chosen Freeholders of Monmouth county is having plans prepared for the construction of a new power plant at the County Court House. Douglas Sprague, 39 Cortlandt street, New York, is architect.

Irvington, N. J.—Plans are under consideration for improvements in the municipal police signal system.

Jersey City, N. J.—Leeds Phonograph Co. has filed plans for the construction of a new one-story brick engine house, to be located at 143 Morgan street.

Newark, N. J.—In connection with the proposed new additions to the plant of the Duratex Co., 768 Frelinghuysen avenue, estimated to cost about $500,000, plans are being prepared for the construction of a one-story addition to the power plant, about 60x75 ft.

Newark, N. J. — Cowan Brothers have filed notice of organization to operate at 123 North Sixth street as a general electrical repairing establishment. Arthur G. Cowan heads the company.

Newark, N. J.—American Transformer Co., 178 Emmet street, has completed arrangements for the disposal of its plant at 484-86 New Jersey Railroad avenue, to new interests. The property consists of a one-story brick structure on a plot about 45x140 ft.

Trenton, N. J.—Trenton Malleable Iron Co. will erect a $20,000 power plant.

Trenton, N. J.—City commission is having new plans and specifications prepared covering the installation of the proposed steam, electric and hydraulic equipment at the municipal waterworks plant. A resolution was recently passed awarding the contract for the proposed work to Harry E. Stahl, the lowest bidder, and this resolution has been withdrawn. Under the new plans, the equipment is estimated to cost about $65,000.

Trenton, N. J. — Fay & Youngs, Inc., 75 Spring street, New York, is planning for the installation of new boiler equipment in the plant of the Fidelity Pottery Co., Trenton, N. J., recently acquired.

Bethlehem, Pa.—Traveler Tire & Rubber Co., 819 North Broad street, Philadelphia, Pa., has completed foundation work in connection with the construction of its proposed local plant, including large power house for works operation. The works will be one-story, about 90x332 ft. located at Traveler avenue and Auburn streets and estimated to cost $125,000.

Easton, Pa.—Easton Hospital Association has awarded a contract to Bechtel & Bechtel, Easton, for the construction of a new three-story hospital building, about 165x230 ft., to be supplemented by a power plant for general operation, the structures to be located at Lehigh, 20th and 22nd streets. The project is estimated to cost $150,000.

Erie, Pa.—Burke Electric Co. has recently completed negotiations for the purchase of the business of the C. & C. Electric & Manufacturing Co., Garwood, N. J., manufacturer of direct-current motors and generators, etc. It is understood that the equipment will be removed to Erie. James Burke is president.

Harrisburg, Pa.—Charles A. Fair, 128 Sylvan terrace, will build a two-story machine shop and auto repair works, 70x120 ft. This work will involve an expenditure of $20,000.

Philadelphia, Pa.—A boiler house involving an expenditure of $50,000

will be erected by the American Preserve Co.

Philadelphia, Pa.—Wicaco Screw & Machine Works, Seventh and Wood streets, is preparing plans for a plant to cost approximately $100,000.

Philadelphia, Pa.—H. O. Wilbur & Sons, Inc., 235 North Third street, has awarded a contract to the Turner Construction Co., 1713 Sansom street, for the construction of a new seven-story and basement brick and concrete power plant and warehouse building, about 80x92 ft.

Pittsburgh, Pa.—Follansbee Brothers Co., operating steel mills at Follansbee, W. Va., has completed arrangements for the construction of a new steel plant at Toronto, Ohio, estimated to cost approximately $5,000,000. The structures will include machine shop, open-hearth and hot mills, annealing departments, scrap shed, and power plant, about 60x100 ft., for general works operations, as well as auxiliary structures.

Pittsburgh, Pa.—Atlantic Refining Co. has filed plans for the erection of a new one-story concrete and steel pumping plant to be located at 57th and Butler streets. The structure is estimated to cost about $35,000.

Rittersville, Pa.—Hildebrand Knitting Co. is having plans prepared for the construction of a large new stack at the power plant at its mills located at Rittersville, near Allentown.

Scranton, Pa.—City is having plans prepared for the construction of a new municipal electric light plant. Frank Koester, 50 Church street, New York, is engineer; Robert W. Allen, City Hall, is director of public works.

Shepherdstown, Pa.—Plans are understood to be under consideration by local interests for the installation of electric service in the municipality. An electric plant will be installed.

York, Pa.—Read Machinery Co., 231 North George street, is having plans prepared for the construction of a one-story brick, concrete and steel boiler plant, about 40x50 ft. The structure will be located on Grantley street, and is estimated to cost $20,000. Gemmill & Billmeyer, 37 West Market street, architect.

Baltimore, Md.—In connection with the proposed improvements in the municipal water supply system, plans have been submitted before the city council covering the construction of a large tunnel from McCall's Ferry to Baltimore over the right of way of the Pennsylvania Water & Power Co., for the tapping of the Susquehanna river for the proposed supply. It is estimated that this project would cost approximately $50,000,000. Howard Bryant is president of the second branch of the city council.

Ehrhardt, S. C.—City will establish an electric light plant according to plans prepared by the Ryan Engineering Co., National Bank of Sumter building, Sumter, S. C.

Jacksonville, Fla.—Installation of a new 10,000-kw. generator will be effected at the municipal electric light and power plant about Jan. 1. This will give the plant a total generating capacity of 19,000 kw. per hour. Additional improvements are also contemplated in the municipal plant.

DATES AHEAD.

American Society of Mechanical Engineers. Annual meeting, New York City, Dec. 2-5. Secretary, Calvin W. Rice, 29 West 39th street, New York City.

American Institute of Chemical Engineers. Annual meeting, Savannah, Ga., Dec. 3-6. Secretary, J. C. Olsen, Brooklyn, N. Y.

Electric Power Club. Meeting, Hot Springs, Va., Dec. 11, 12 and 13. Headquarters, Homestead Hotel. Secretary, C. H. Roth, 1410 West Adams street, Chicago.

National Council of Lighting Fixture Manufacturers. Annual convention, Detroit, Mich., February, 1920. Secretary-treasurer, Charles H. Hofrichter, Cleveland, Ohio.

American Electrochemical Society. Annual convention, Boston, Mass., April 7-10, 1920. Friday, April 9, joint session with American Institute of Electrical Engineers on "Electrically Produced Alloys." Secretary, Joseph W. Richards, Bethlehem, Pa.

National Electric Light Association. Annual convention, Pasadena, Cal., May 18-21, 1920. Headquarters, Hotel Huntington. Acting secretary, S. A. Sewall, 29 West 39th street, New York City.

NORTH CENTRAL STATES.

Lima, Ohio.—Rates for boulevard and arc light service in Lima will be submitted to the joint committee of clubs and civic organizations by the Ohio Electric Co. The Ohio Electric Co. is to submit its figures for the boulevard in two ways, under one of which it will install and own the equipment, and under the other the city will install the posts and wires and buy only the current.

Oberlin, Ohio.—The city proposed to erect an electric power plant.

Evansville, Ind.—Evansville Metal Bed Co. has purchased two entire blocks adjoining its factory and a large addition will be built.

Brockton, Ill.—The council is planning ways and means to secure electric lighting. Address C. B. Miller.

Chicago, Ill.—Central Manufacturing Co. will erect a $900,000 six-story warehouse, 260x174 ft.

Chicago, Ill.—Central Bag Manufacturing Co. is erecting a new factory building to cost $350,000.

East St. Louis, Ill.—St. Louis Pressed Steel Co. will erect the first unit of a factory plant, the building to be a steel and brick structure, 200x100 ft., and the estimated cost $65,000. The Sutherland Building Construction Co., St. Louis, Mo., has the contract.

Elgin, Ill. — Donald Hubbell will erect two-story brick building to cost $28,000.

Monticello, Ill. — Township has voted to erect $200,000 community high school.

Sorento, Ill.—The sum of $5000 in bonds has been voted to secure electric lighting.

Bangor, Mich. — The village, after operating a municipal electric plant for about 15 years, has sold it and granted a franchise to the Benton-Harbor-St. Joe Railway & Light Co.

Detroit, Mich. — Notice has been filed with the Secretary of State by the Detroit Edison Co. of an increase in its capital stock from $35,000,000 to $60,000,000, to provide for general expansion.

Hartford, Mich.—The village has granted to Anderson Brothers a substantial increase in rates for electric current. In return for the higher rates, Anderson Brothers will install a new power plant with new waterwheels and vertical direct-connected generators. Orders for this machinery will be placed this year for delivery about next June.

Lawton, Mich. — A committee has been appointed to obtain information relative to the amount necessary to install a modern electric light plant. It is probable that a special election will be called this year. Address village clerk.

Muskegon, Mich. — Shaw Electric Crane Co. contemplates an addition to its plant which will double its capacity.

Westphalia, Mich.—The council has received an estimate for construction of a municipal lighting system. The expert figures will not exceed $15,000 to install the system and to build a suitable shelter for the dynamo and engine. The council will submit the question to the voters some time in December.

Manitowoc, Wis. — Chamber of Commerce is interested in ornamental lighting system on several streets. Arthur Zander, city clerk.

Waupaca, Wis.—Waupaca Electric Service & Railway Co. has under consideration the erection of a new electric plant.

Faribault, Minn.—The Faribault division of the Northern States Power Co. will shortly furnish 100-hp. of electrical energy for operation of a stone quarry on the outskirts of the city.

SOUTH CENTRAL STATES.

Gadsden, Ala. — City council has called a special election on Jan. 6 for the purpose of voting on a bond issue of $100,000 to cover the cost of the establishment of a municipal electric light plant. Ernest Smith is city engineer.

Huntsville, Ala.—The new transmission line of the Alabama Power Co., which will bring power from Goose river near Gadsden to Huntsville for distribution throughout northern Alabama, will be finished by the first of the year. Preparations are being made for the erection of two large steel towers on each side of the Tennessee river at Whitesburg, where the crossing will be effected. A line is being extended to Decatur and Albany, which will be completed about the same time.

Jackson, Miss—Plans are being arranged by the city for the installation of new equipment in the municipal electric plant. Bonds for $15,000 have been voted to cover the cost of the proposed work. F. M. Trussell, is clerk.

Hominy, Okla. — City considering plans for the installation of a new

electric street lighting system. C. E. Lee is engineer.

Shattuck, Okla.—City Council, A. C. Oliver, Mayor, has taken bids for the installation of a quantity of new equipment in the municipal electric plant, including boilers, generating apparatus, lifting equipment, heater, pumping units, switchboard, and auxiliary apparatus. Improvements and extensions will also be made in the municipal water supply system, pole lines, etc. Burns & McDonnell, 402 Interstate building, Kansas City, Mo., are engineers.

Sapulpa, Okla. — The 66,000-volt transmission line of the Oklahoma Gas & Electric Co. connecting Drumright and Sapulpa has been completed and much needed additional capacity is now available for the Sapulpa division.

Abilene, Tex. — Work will begin Dec. 1 on the construction of a combined power and ice plant in Abilene to cost $700,000, according to an announcement made by A. Hardgrave, Dallas, vice-president and general manager of the American Public Service Corp. The building will be of reinforced concrete throughout. A turbine of 2600 hp. will generate power for the plant, which will supply electric current to seven towns in this section.

Brady, Tex.—City has let first contract for electric light plant. Address Mayor.

Houston, Tex.—It is planned by the Harbor Board and city council of Houston to take up for consideration soon the matter of extending the municipal belt railroad to Morgan's Point, situated on the south side of the Ship Channel, and to Goose Creek, situated on the north side and to convert the system into electric traction. It is also proposed that the lines be double-tracked and equipped to carry passenger as well as freight traffic. The plans also include the merging of the Municipal Belt railroad and the city's port properties at Port Houston into a terminal corporation for the issuing of bonds. It is stated by City Engineer McVea that these properties have a value of more than 2,500,000, including 465 acres of land on the Ship Channel. It is estimated that the cost of the main line extension to Morgan's Point and Goose Creek would be about $1,000,000.

Killeen, Tex. — Fire recently destroyed the plant of the City Light & Power Co., with loss estimated at $28,000. It is understood that plans will be arranged for immediate rebuilding.

WESTERN STATES.

Hardin, Mont.—Big Horn Canyon Irrigation Co. with a capital of $5,000,000 will build reservoir 60 miles long. About 1,500,000 yds. of concrete will be required for dam. Approximately 40,000 acres of land will be irrigated with the aid of pumps operated by power generated from the dam. Address secretary of company.

Chehalis, Wash. — City Engineer Bantz will report his complete specifications for the proposed new lighting system for Chehalis' streets at the next meeting of the city commission. The plan proposed a concrete or steel standard with a single globe and 400-watt lamps at reasonable intervals in the business center of the city and make Chehalis one of the best lighted Northwest cities.

Goldendale, Wash. — The power house is to be entirely overhauled. The flume and piping are to be repaired and replaced when necessary.

Bend, Ore.—At a recent meeting of the city council the mayor suggested that an adequate system of municipal lighting should be adopted.

Roseburg, Ore.—The question of issuing $500,000 electric light bonds is under consideration. Address Mayor Hamilton.

Modesto, Calif. — On Dec. 9, the question of issuing $20,000 bonds for street lighting equipment will be submitted to vote. Address city clerk.

CANADA.

Bala, Ont.—Bala Electric Light & Power Co., is constructing a 14-mile pole line, and also contemplates the construction of another line the same length.

Vancouver, B. C. — Canadian Marconi Wireless Co. contemplates the erection of a wireless station to cost $2,000,000 and is negotiating with the Government for license.

PROPOSALS

Transformers—Bids will be received by the Committee of Fire, Water, Light and Power, Winnipeg, Man., at the office of C. J. Brown, city clerk, until 3 p. m., Dec. 1, for the supply and installation of six 1000-kv-a. step-down, single-phase transformers for the city light and power department. Specifications may be obtained at the office of the city light and power department, 54 King street.

Fire Alarm Boxes.—Bids will be received by the commissioner of gas and electricity, Room 614, City Hall, Chicago, on Nov. 28, for furnishing and delivering to the city, 20 fire alarm boxes complete, in accordance with specifications on file in the office of the above official. William G. Keith, commissioner of gas and electricity.

Electric Elevators. — Bids will be opened in the office of the supervising architect, Treasury Department, Washington, D. C., at 3 p. m., Dec. 2, for remodeling the electric freight elevators in the United States Post Office, Court House and Custom House at Providence, R. I., in accordance with specifications, copies of which may be had at the above office, in the discretion of the supervising architect. James A. Wetmore, acting supervising architect.

Electrical Work.—Bids will be received at the supervising architect's office, Treasury Department, Washington, D. C., on Dec. 18, for furnishing materials for the construction of the United States Post Office at Thomasville, N. C., including millwork, painting, glazing, hardware, heating, electric work, etc., in accordance with drawings, specifications and bills of quantities attached thereto, copies of which may be obtained from the custodian of the site at Thomasville, N. C., or at the above office, in the discretion of the supervising architect. James A. Wetmore, acting supervising architect.

NEW PUBLICATIONS

Safe Practice in the Use of Wire Ropes in Mines.—The Bureau of Mines in the course of its investigations of safety in mining, the fuels and mechanical equipment has collected much information bearing on the use of wire rope. In this paper by R. H. Kudlich and O. P. Hood, the authors outline approved practice and the most important precautions to insure safety. It emphasizes the essentials of good practice and gives the reasons underlying such practice.

Abatement of Corrosion in Central Heating Systems is the title of technical paper No. 236 by F. N. Speller and issued by the Bureau of Mines, Department of the Interior, and serves as a guide to engineers in the design of heating systems. The author emphasizes the fact that whether hot water or steam is used as the medium for conveying heat to the consumer, a heavy toll in upkeep must be faced sooner or later if the corrosion of piping is not taken into account in the design of the plant. It has been found that the main source of corrosion has been traced to dissolved gases brought into the heating system either with the feed water for the boiler or through leaks in return lines under a pressure below that of the atmosphere. This publication discusses piping material, theory of corrosion and the engineering problem involved in heating systems. The price of this publication is 5 cts. and copies may be secured by addressing the Superintendent of Documents, Government Printing Office, Washington, D. C.

Photoelectric Spectrophotometry by Null Method.—The Bureau of Standards, Department of Commerce, has issued scientific paper No. 349 by, K. S. Gibson, entitled "Photoelectric Spectrophotometry by the Null Method." In connection with the color-standardization work of the Bureau of Standards, it was found desirable to have available a number of independent methods of making spectrophotometric determinations, especially in the visible part of the spectrum; for it is generally admitted that the fundamental basis of color specification is spectrophotometry. To supplement the other methods at present in use at the Bureau, the author was given the problem of developing a method for accurate and convenient photoelectric spectrophotometry suitable for routine determinations, and the results of his study are described at length in this publication. It discusses the apparatus, method and errors and accuracy in spectral trans-

mission, diffusion of spectral reflection and other applications of the apparatus. The price of this bulletin is 5 cts. and is sold by the Superintendent of Documents, Government Printing Office, Washington, D. C.

INCORPORATIONS

Holmesville, Neb. — Consolidated Electric Co. has incorporated with a capital of $10,000. Plans to build electric line from Holmesville, taking in towns of Rockford, Filley and Virginia.

Cylon, Wis.—Cylon-Forest Electric Co. has incorporated with a capital of $25,000. Herman Frey & John F. McNamara.

Carthage, Miss.—Carthage Light & Ice Co. has been incorporated with a capital of $30,000. R. L. Jordan and others.

Wenatchee, Wash.—Articles of the incorporation were filed by Columbia Railway Electric Co. for $5000 by W. L. Chrysler, and Edith F. Chrysler.

Chesterfield, Ill.—Chesterfield Electric Co. has been incorporated with a capital of $15,000 by W. J. Finch, D. Ambier and L. Ambier.

Indianapolis, Ind.—Adams-Coulter Manufacturing Co. has been incorporated with capital of $35,000 for the manufacture of machinery. L. P. Adams, A. L. Coulter and Walter G. Holt are the incorporators.

Muncie, Ind.—Star Storage Battery Co. has been incorporated with capital of $25,000 to manufacture electric storage batteries. Address W. O. Haymond, Muncie, Ind.

New York, N. Y.—Worth Lighting Fixture Co. Capital, $10,000. To manufacture electric and gas fixtures, etc. Incorporators: J. Pecker, B. Shapiro and B. Leavitt, 311 East Ninth street.

New York, N. Y.—Blair Reseater Co. Capital, $50,000. To manufacture engines, motors, and kindred equipment. Incorporators: A. Hall, F. R. Howe and D. M. Gerard, Huntington.

Brooklyn, N. Y.—Aws Manufacturing Co. Capital, $10,000. To manufacture electrical and gas appliances, etc. Incorporators: A. Schachne, I. Kantrowitz, and A. W. Schenker, 469 West 164th street.

Brooklyn, N. Y.—Art Fibre Productions, Inc. Capital, $20,000. To manufacture lighting fixtures, etc. Incorporators: M. Appelbaum and F. and H. Adlow, 37 Linden street.

Buffalo, N. Y.—Huron Electric Co. Capital, $10,000. To manufacture electrical goods, etc. Incorporators: E. A. Heller, S. Eckert and E. J. Hanks.

Danville, Pa.—Penns Creek Hydro Electric Co. Capital, $30,000. To operate a hydroelectric power plant. Incorporators: Miles A. Ziegler, New Berlin; F. Q. Hartman, and A. Pritchard, Danville.

Wilmington, Del. — Extemp-Fone Company. Capital, $125,000. To manufacture telephone attachments, equipment, etc. Incorporators: M. Butler, B. M. Barrett, and M. M. Lucey, Wilmington.

Charlotte, N. C.—Owen Light & Power Co. Capital, $100,000. To operate a local light and power plant. Incorporators: S. D. Bagwell, J. V. Simms, and H. C. Irvin.

Walnut Cove, N. C.—Dan Valley Power Co. Capital, $50,000. To operate a local electric light and power plant. Incorporators: O. N. Petree, H. L. Mitchell and J. W. Slate.

Gurdon, Ark.—Gurdon Light & Power Co. Capital, $20,000. To operate a plant for the generation and distribution of electric energy. T. Neely is president.

Albany, Tex. — Albany Light & Power Co. Capital, $30,000. To operate a local electric light and power plant. T. B. Wood is the principal incorporator.

Logan, W. Va.—Newman Electric Co. Capital, $10,000. To manufacture electrical goods. Incorporators: J. G. Biggs and L. Niederlenner, Jr., Huntington, and H. C. Newman, Logan.

Toledo, Ohio—Lucas Electric Co. has incorporated with a capital of $25,000. Frank L. Lucas and George I. Michener, incorporators.

Grand Rapids, Mich.—Grand Rapids Electric Service Co. has incorporated with a capital of $8000. Ora E. Richards, Grand Rapids, William J. Burns, and William W. Pennington, Detroit.

Washington, D. C.—Federal Battery Manufacturing Co. Incorporated under Delaware laws with a capital of $3,000,000. To manufacture electric batteries, etc. Incorporators: M. E. Jones, Richard B. Owen, and William H. Benjamin, Washington.

Tulsa, Okla.—W. H. Youse Electric & Supply Co. Capital, $25,000. To manufacture electrical supplies, etc. W. H. Youse is the principal incorporator.

New York, N. Y.—Rice & Ganey, Inc. Capital, $40,000. To engage in a general electrical contracting capacity. Incorporators: W. H. Schneider, O. L. Perrault, and H. T. Cooper, Albany.

New Rochelle, N. Y.—Ameritoy Co., Inc. Capital, $20,000. To manufacture electrically operated toys and novelties, etc. Incorporators: A. M. Joslyn, J. O. Miller, and A. M. Nowell, New Rochelle.

Albany, N. Y.—Fine Wire Insulating Co. Capital, $10,000. To manufacture insulation specialties, wires, etc. Incorporators: M. D. Shiverick, and F. H. and D. H. Tyler, Albany.

Binghamton, N. Y.—Southern Tier Electrical Supply Co. Capital, $35,000. To manufacture electrical supplies, etc. Incorporators: E. A. and A. H. Hyde and E. C. Wehle.

Philadelphia, Pa.—Daynix Engineering & Power Co. Incorporated under Delaware laws with a capital of $200,000. To engage in general electrical engineering, etc. John C. and V. H. Daynix and H. Frances Taylor, Philadelphia, are the incorporators.

FOREIGN TRADE

[Addresses of firms referred to in these trade opportunities may be obtained by writing to the Bureau of Foreign and Domestic Commerce, Washington, D. C., or its branch and local co-operative offices. Request for each opportunity should be on a separate sheet and the file number given.]

Electrical Goods (31,158).—A commercial agent from Australia desires to purchase and secure agencies for the sale of hardware, draperies, electrical goods, tools, stoves, clothing, dry goods, knit goods, cosmetics and pumps. Reference.

Machine Tools, Etc. (31,223).—A business man in England desires to secure an agency or act as sales manager or representative of electrical and mechanical engineering firms, motor-car manufacturers, machine tools, automobile accessories; and also manufacturers of gas and chemicals, as he is familiar with these products. Payment, salary and commission basis. References.

Electrical Instruments (31,227).—An agency is desired by a commercial agent in Switzerland for the sale, of foodstuffs, machines, colonial products, iron articles, cotton, animal hair, electrical instruments and apparatus, typewriters, etc. Quotations should be given c. i. f. Genoa. Payment in Italian currency, account current, within 30 to 60 days. Correspondence should be in Italian, French or German. References.

Electrical Supplies (31,228). — A commercial agent in Spain desires to secure agencies for the sale of iron and steel sheets, hardware, electrical supplies, drugs and chemical products. Quotations should be given c. i. f. Spanish ports. Payment preferred 30 days from shipment. Correspondence should be in Spanish or French. References.

Electrical Material (31,269).—A firm in Spain desires to secure agencies for the sale of steel electrical material and supplies, copper, steel and iron wire, office supplies, cheap jewelry, rubber goods, etc. Correspondence should be in Spanish. References.

Turbines, Boiler Equipment (31,271).—An engineer in Belgium desires to purchase and secure an agency for the sale of industrial material and machines, turbines, boiler equipment, lathes, planers, shapers, etc. Quotations should be given c.i. f. Antwerp and Brussels. Terms, payment against documents or with bank credit. Correspondence should be in French. Reference.

Electric Light Plant (31,279).—The partner of a firm in Uruguay will shortly arrive in the United States and desires to secure agencies for the sale of textiles, industrial chemicals, medicinal and industrial oils, electric light plants for farms, automobiles, etc. Quotations should be given c. i. f. Montevideo. Correspondence may be in English. References.

Personals

Paul M. Lincoln Becomes Consulting Engineer of Lincoln Electric—G. T. Seely Joins Youngstown Utility—Changes

E. W. Doty, formerly connected with Doty & Bienemann Public Utility Service, Columbus, Ohio, has become associated with Nau, Rusk & Swearingen, 901 American Trust building, Cleveland.

Charles S. Hammond, recently with Lockwood, Greene & Co., has joined the Georgia Railway & Power Co., Atlanta, Ga., in the capacity of power sales engineer, succeeding J. E. Mellett, resigned.

William L. Moorhead, who recently resigned as vice-president of the Duquesne Electric Manufacturing Co., Pittsburgh, is now affiliated with Henry T. Parsons, who will conduct a general machinery business under the name of Parsons-Moorhead Machinery Co. at 237 Fourth avenue, Pittsburgh.

Harold H. Smith, formerly electrical engineer with the Edison Storage Battery Co., has resigned to become chief engineer of the Transportation Engineering Corp., 200 Fifth avenue, New York. This company acts as railway distributor for Edison storage batteries, "Automatic" industrial trucks and tractors and accessories.

L. S. Horner, vice-president of the Acme Wire Co., New Haven, Conn., has been honored with a special citation received from the Brtish Government, awarded in recognition of his war work as chief of the executive staff of the Bureau of Aircraft Production, engaged in the development and production of aircraft during the late war.

Capt. C. E. Grunsky, Jr., has resumed his engineering work in San Francisco with the C. E. Grunsky Co., a reorganization of the American Engineering Corp. Captain Grunsky had been with the U. S. Army for two years, during which time he saw active service at the front and supervised the valuation of war losses in French mines.

Joseph Jacobs, recently returned from overseas service with the U. S. Army, has resumed his engineering practice with offices at 1317-18 Smith building, Seattle, Wash. He will specialize, as heretofore, in diking, drainage irrigation and general water supply and land development projects, public utility valuations and engineering consultation in connection with cases before the courts.

Clifton R. Hayes, manager of the Fitchburg Gas & Electric Co., Fitchburg, Mass., has become associated with Charles H. Tenney & Co., Boston, engineers and managers of gas and electric light plants, as engineering manager of their system from Maine to New Jersey, with headquarters at Boston. Mr. Hayes is president of the New England Section of the National Electric Light Association.

Paul M. Lincoln, for many years commercial engineer of the Westinghouse Electric & Manufacturing Co., East Pittsburgh, has resigned from that organization to enter the consulting engineering field, and in that capacity will have active charge of motor application engineering for the Lincoln Electric Co., Cleveland, Ohio. Mr. Lincoln is well known in the electrical engineering profession and to him are accredited many notable pieces of engineering work, the following being perhaps the best known: The design and installation of the first hydroelectric power plant at Niagara Falls, the operation of which he subsequently directed for six years, and the development of the first high-voltage transmission lines. On this latter subject he is considered the best known authority in the world. He has also perfected many other notable inventions including the Lincoln synchronizer for paralleling large electric alternators for which he has received various medals and awards. He was elected president of the American Institute of Electrical Engineers in 1914 and has served for many years on the Board of Directors and on the Transmission Comittee of the Institute.

Paul M. Lincoln.

The work which Mr. Lincoln will take up with the Lincoln Electric Co. involves the entire problem of motor drive for machinery, and especially the determination of the proper type, characteristics and sizes of motors best adapted for direct connection to various sizes and types of machinery. After this problem has been worked out for each particular machine, the motor will then be direct-connected to the machine at the plant where the machine is made and delivered to the user as a complete, self-contained unit. The Lincoln company is indeed to be congratulated on securing the services of one who has had such extensive experience in the profession and unlimited ability to solve this very important problem in electrical and mechanical engineering; and it is expected that its solution will tremendously increase the efficiency of electric motor drive and will make for increased production and efficiency in general manufacturing work.

F. C. Biggert, Jr., for a number of years chief engineer and second vice-president of the United Engineering & Foundry Co., Pittsburgh, has been made president of the company. He succeeds Isaac W. Frank, who recently resigned, but who will serve as chairman to the executive board. K. C. Gardner, former manager of sales of the rolls department, has been elected to succeed Mr Biggert as second vice-president.

C. J. Cooper, Jr., who recently resigned as general manager of the Mineral Point Public Service Co., has become connected with the Chicago office of the Hoover Suction Sweeper Co., where he will engage in sales promotion work. Prior to his connection with the Mineral Point company, Mr. Cooper was superintendent of heating and assistant general manager of the Merchants Heat & Light Co., Indianapolis, Ind.

E. L. Milliken, secretary and manager of the Houghton County Electric Light Co., Houghton, Mich., has resigned to become manager of the Houston Electric Co., Houston, Tex., and will handle street railway problems. Mr. Milliken is a native of Maine, and has spent the greater part of his business career with the Stone & Webster organization. While with the Houghton company, he had charge of both the street car system and extensive interurban lines and the lighting system, and the experience he has gained while engaged in this work eminently fits him for his new duties with the Houston company.

John C. Lynch, general superintendent of traffic of the Bell Telephone Co. of Pennsylvania, Philadelphia, has been promoted to the position of vice-president and general manager, succeeding L. H. Kinnard, now president of the company. He is a New Englander by birth, having been born Jan. 15, 1875, at Stockbridge, Mass. After attending Williams Academy he entered Cornell University, and was graduated from the latter institution with the degree of mechanical engineer in 1896. In the same year he entered the telephone business, his first position being traffic inspector for the New York Telephone Co. in Manhattan. A year later he was made assistant traffic manager of Franklin central office. After being transferred to other New York offices, he was made manager at Riverside in 1899, each of these positions being an advancement, carrying with it larger

responsibilities. He was for six years traffic engineer of the New York Telephone Co., and later became division superintendent of traffic for the New York & New Jersey Telephone Co., which company was later consolidated with the New York Telephone Co. About 1909 when the organization of the New York "Up-State" Bell companies was effected, Mr. Lynch was largely instrumental in making the traffic force a highly efficient organization. In 1913 he removed to Philadelphia to accept the position of general superintendent of traffic, and continued in this capacity until his recent promotion.

GARRETT T. SEELY, for the last eight years assistant general manager of the consolidated system of Elevated Railroads of Chicago, has been elected vice-president and general manager of the Mahoning & Shenango Railway & Light Co., with general offices in Youngstown, Ohio. Mr. Seely, who is a native of Illinois, having been born in Oswego, is a graduate of Beloit College Academy (1895) and of the University of Illinois (1899). During his college days and after being graduated he did engineering work from 1896 to 1900 on the Atchison, Topeka & Santa Fe Railroad system in various parts of Kansas, Colorado and Oklahoma. In the latter year and until he became engineer of maintenance of the Chicago South Side Elevated Railroad in 1901, he was engaged in engineering on track elevation work in Chicago. He continued as engineer of maintenance till 1908, when he became assistant general manager of the South Side Elevated and in 1910 he was advanced to second vice-president and general manager of the same road. In 1911 he became assistant manager of the consolidated system of Elevated Railroads, a position which he relinquishes to become operating head of the combined railway, lighting and power system in northeastern Ohio and northwestern Pennsylvania with headquarters in Youngstown. Mr. Seely is a member of the Western Society of Engineers, the Chicago Engineers Club, the South Shore Country Club and the Flossmoor Country Club. He also has been active in the American Electric Railway Association and is third vice-president of the American Electric Railway Transportation and Traffic Association. Mr. Seely and his family will remove from Chicago to Youngstown about Dec. 1, when he will assume his new duties.

Garrett T. Seely.

RUSSELL W. STOVEL, who recently returned from France, where as lieutenant-colonel of engineers, he served as chief of the Terminal Facilities Division of the Army Transport Service, has been appointed a consulting engineer of Westinghouse, Church, Kerr & Co., Inc., New York City, and, as a member of that organization, will devote his entire time to the company's electrical and mechanical work. Mr. Stovel has had an unusually comprehensive experience in the electrical and mechanical problems connected with central power station and steam railroad electrification work, from the fundamental economics involved, to design, construction, equipment and operation, together with a most valuable experience in mechanical handling at docks and terminals. He was graduated from McGill University in 1897 with the degree of Electrical Engineer, and the following year entered the employ of Westinghouse, Church, Kerr & Co. He soon became an assistant engineer, then successively engineer-in-charge and mechanical engineer of the company, and finally a managing engineer.

Some of the important work handled by Mr. Stovel while with the Westinghouse, Church, Kerr company was the design and construction of the power plants of the Utah Light & Railway Co., Salt Lake City, Utah; Meriden Light & Railway Co., Meriden, Conn.; Edison Electric Illuminating Co., York, Pa.; the design and construction of passenger terminal and steamboat pier of the Canadian Pacific Railway, Vancouver, B. C.; the design of the proposed power station of the Pennsylvania Railroad at Harrison, N. J.; the design of extension to the power plant at Cos Cob, Conn., of the New York, New Haven & Hartford railroad; design and construction of the power plant of the Wabash-Pittsburgh Terminal, Pittsburgh, and the design and construction of the machine shop of the Chicago Railway Equipment Co., Chicago, Ill. In 1914 Mr. Stovel left the company to become managing engineer for Gibbs & Hill, consulting engineers, New York. For this company he had direct charge of the Paoli and Chestnut Hill electrifications of the Pennsylvania railroad, the Elkhorn Grade electrification of the Norfolk & Western railway, and the electrification of the New York Connecting railway.

Lieutenant-Colonel Stovel's work in France is well summarized in the following letter from his commanding officer: "Entering the service Oct. 6, 1917, and arriving in France on Nov. 8, 1917, this officer was assigned to duty with the chief engineer, Transportation Service, and in view of the excellent results obtained in his work in connection with the provision and installation of the electrical and mechanical equipment of the Transportation Service, was on Aug. 22, 1918, transferred to the office of the director, Army Transport Service, as electrical and mechanical engineer in charge of the Pier Utilities Branch of the Terminal Facilities Division. His grasp of the problems involved in providing adequate facilities to permit the discharge of 100,000 tons a day necessary to meet the proposed program of an army of 4,000,000 men in France was so complete that on Sept. 2, 1918, he was designated as chief of the Terminal Facilities Division and placed in charge of all matters relating to the procurement, maintenance and operation of all terminal facilities under the jurisdiction of the Army Transport Service, including all dock, wharf and warehouse structures, cranes, conveyors, tractors, and all other electrical and mechanical appliances and installations. His wide experience gained as an engineer in civil life, his high technical attainments, tact, energy and force brought immediate results, so that within a comparatively brief time he had reorganized the Terminal Facilities Division at the principal ports and had well in hand all matters pertaining to the provision, maintenance and operation of the required terminal equipment. To the untiring, farseeing work of this officer and to his splendid administrative abilities are due the excellent results obtained by the Terminal Facilities Division of the Army Transport Service." Mr. Stovel is a member of the American Institute of Electrical Engineers and the American Society of Mechanical Engineers.

Russell W. Stovel.

Obituary.

E. T. PARDEE, manager of the New York office of the Allis-Chalmers Manufacturing Co., passed away on Nov. 14 at the New York Hospital at the age of 50 years. He had been in poor health and had had a serious breakdown early this summer. On Thursday, Nov. 13, he was taken ill in his office and taken to the hospital where he died on Friday morning of cerebral hemorrhage. He was born at New Haven, Conn., May 28, 1869. He was with the old Fort Wayne Electric Co. in its early days as a salesman and for about the last 20 years had been connected with the Bullock Electric Manufacturing Co. and the Allis-Chalmers Manufacturing Co. He subsequently held the offices of manager of the Boston office, manager of the power and electrical department, manager of the Bullock Works, and since 1915 up to the time of his death served the company as manager of the New York office.

Financial News

Public Utility Companies Financing Extensions with Stock.

Despite adverse conditions affecting public utilities arising from war prices and fixed rates and fares, these corporations have been able to do considerable financing recently by means of stock issues sold to the public. Total amount of stock sold by public utilities corporations so far in 1919 is $53,601,490. This compares with $614,858,600 preferred and $514,948,500 common stock sold by industrial corporations.

Many utility corporations, particularly traction and gas companies, are in need of money for expansion purposes but owing to their curtailed earning power wherever they have been obliged to operate under rates and fares which prevailed before the war, financing cannot be successfully promoted at present time. The situation, however, is slowly but surely improving and through courts and public utility commissions many of the companies have been authorized to increase rates and fares to meet higher operating costs.

With improvement in the general situation it is expected that much new financing will be done by public utilities and their securities which have always as a class been regarded highly in peace times, will eventually work back to their former position.

Public Service Co. of New Jersey sold the largest amount of preferred stock during the year, $10,000,000 8% stock. This was offered to stockholders at par. Ohio Cities Gas Co. sold $9,187,500 of common stock which was the largest issue of that class floated.

Below is given a list of public utility corporations which have brought out preferred or common stock, from Jan. 1 to Oct. 31 this year, with rate and amount as compiled by Dow, Jones & Co.:

PREFERRED STOCK.

Corporation.	Rate.	Amount.
Public Service of New Jersey	8	$10,000,000
Pacific Gas & Electric 1st..	6	5,000,000
Cities Service N. Y. Class B. ..		3,000,000
Central Utilities Securities Co.	6	2,195,000
Hackensack Water Co.	7	2,000,000
Dixie Terminal Co.	6½	1,500,000
Gt. Western Power of Cal..	7	1,500,000
Dallas Power & Light Co...	7	1,000,000
Colorado Power Co.	7	1,000,000
Wash., Balt. & Annapolis Elec. Ry.	6	783,190
Erie Lighting Co.	7	500,000
Indiana Coke & Gas Co. ..	7	500,000
*Miscellaneous		1,349,200
Total preferred stock		$30,327,390

COMMON STOCK.

Ohio Cities Gas Co.	$9,187,500
Lone Star Gas Co.	4,000,000
Oklahoma Natural Gas Co.	3,000,000
Southern California Edison Co...	2,500,000
Turner Falls Power & Electric Co.	2,409,100
Hartford Electric Light. Co.	1,500,000
*Miscellaneous	677,500
Total common stock	$23,274,100
Total preferred and common stock	$53,601,490

*Aggregate of issues less than $500,000.

Rochester Railway & Light Changes Name.

At a recent meeting of the stockholders of the Rochester Railway & Light Co., it was voted to change the corporate name of the company to the Rochester Gas & Electric Corp. An increase in capitalization of $1,000,000 was also voted, making the authorized capital of the company $18,250,000.

E. G. Long & Co., 50 Church street, New York, manufacturer of electric railway metals, has filed notice with the Secretary of State of an increase in its capital from $50,000 to $100,000, to provide for proposed business expansion.

Foreign Finance Corporation Formed.

The Foreign Finance Corp., with an authorized stock capital of $10,000,000, has been formed primarily to invest funds in enterprises or securities which held forth promise of safe and satisfactory return.

This new corporation is backed by a powerful group of bankers. Arthur M. Anderson of the firm of J. P. Morgan & Co. will be president.

The board of directors will include J. P. Morgan, H. P. Davison, James S. Alexander, George F. Baker, Jr., George W. Davison, Harvey D. Gibson, Seward Prosser, Charles H. Sabin, James Stillman, Albert H. Wiggin and A. M. Anderson. The new corporation is incorporated under the laws of New York and will deal in securities of foreign countries and go into any field that looks safe and attractive.

General Gas & Electric Revenue Increase.

Preliminary statement of earnings of General Gas & Electric Co., comprising all subsidiaries acquired through recent reorganization, shows total operating revenue of $853,873 for October, 1919, which compared with $687,290 for October, 1918, is an increase of $166,583, or 24.2%.

The month of October indicated the largest kilowatt-hour output of any month since the new plant of the Binghamton Light, Heat & Power Co., a subsidiary, has been in operation. Total generation for the month was 1,726,960-kw-hr., while it is confidently expected that the 2,000,000-kw-hr. output mark will be reached before the end of the year.

According to advices from Columbus, Ohio, the Logan Natural Gas Co., one of the largest gas producing companies in the Middle West and which supplies the city of Sandusky through the Sandusky Gas & Electric Co., subsidiary of General Gas & Electric Co., has asked the State Public Utilities Commission to allow it to abandon its service in 50 towns and cities in the state of Ohio.

Standard Gas & Electric Balance on Common Stock.

Earnings of Standard Gas & Electric Co., subsidiaries, exclusive of oil properties, which are applicable to Standard Gas & Electric Co., compare as follows:

	12 mos. to Sept. 30.	6 mos. to June 30.
Gross earnings	$2,509,837	*.....
Net after taxes	2,434,030	$1,377,011
Surplus after charges	1,530,737	890,365
Balance after preferred dividends	662,355	446,404
Balance after mort. of disc.	607,355	*.....

*Not available.

The balance for the 12 months ended Sept. 30, 1919, is equal to approximately $2.40 a share, or 4.8% on the common, including the increased common stock issued in payment of 13% accumulated dividends on the preferred. In addition applicable net earnings from Shaffer Oil & Refining Co. for the first nine months of 1919 are estimated at $675,000 on the majority common stock in this company acquired by Standard Gas & Electric Co. as of Jan. 1, 1919.

On the basis of current earnings of Shaffer Oil & Refining Co., the Standard Gas & Electric Co.'s share for the full 12 months of 1919 should be approximately $900,000, while the electric light, power, traction and other departments should contribute approximately $890,000. The latter estimate is based on the showing for the first six months of 1919, during which period the earning power of the company showed improvement which has been steadily maintained since that time.

The total from all departments, including oil subsidiaries, should therefore show approximately $1,790,000 for the calendar year equal to about $7 a share, or 14% on the outstanding common stock, after payment of the regular 8% dividend on the cumulative preferred stock.

Arkansas Company to Issue Stock.

Permission has been granted by the Arkansas Corporation Commission to the Arkansas Light & Power Co. and the Pine Bluff Co., an auxiliary, to issue certain amounts of preferred stock and bonds. The Arkansas Light & Power Co. proposes to issue $150,000 of 7% preferred stock and $50,000 6% bonds, and the Pine Bluff Co. $25,000 7% preferred stock and $25,000 6% bonds.

DesChutes Falls Company to Operate in Oregon.

DesChutes Falls Power Co., capitalized at $5,000,000, has been granted permission by the State Corporation Commission to operate and will engage in a general business in the distribution of electricity for heat, power and light. The main offices of the company, which is organized under the laws of Nevada, are in Carson City, Nev. A. M. Wright, vice-president of the United States National Bank of Portland, is named as attorney in fact.

Pennsylvania Utilities Income Shows Increase.

Pennsylvania Utilities System, composed of the Pennsylvania Utilities Co., the Eastern Pennsylvania Power Co., and the Easton Gas Works, has issued a statement showing an increase of 33⅓% in operating income during the month of September, as compared with the corresponding month for the previous year. The operating income for this month in 1919 was $50,317.47, as against $37,696.73 in 1918. The operating revenues in this month for each respective year were $155,571.66 and $133,494.21. This is an increase of 16.5%.

Idaho Power Earnings Show Substantial Gain.

Earnings statement of Idaho Power Co., controlled by the National Securities Co., for the 12 months ended Sept. 30, 1919, shows surplus after interest charges and other deductions of $407,379, equivalent to $39.55 a share on the 10,300 shares of 7% cumulative preferred stock outstanding, which includes 320 shares held in the treasury.

This compares with $39.23 and $37.41 earned on outstanding stock for the 12 months ended August and July, respectively.

Earnings for September and 12 months ended Sept. 30 compares as follows:

	1919.	1918.
September gross ....$	191,544	$ 159,006
Net after taxes	107,528	88,601
Surplus after charges	73,491	49,786
12 months gross	1,700,189	1,483,375
Net after taxes	806,306	715,054
Surplus after charges	407,379	325,925

The company has a total installed generating capacity of 36,315 kw. in plants leased or owned. With one exception all plants are interconnected by a comprehensive system of transmission lines aggregating 1106 miles in length. The population served is estimated at 150,000.

Public Offered Louisville Gas & Electric Stock.

In order that consumers of gas and electric power in Louisville may become partners and share in the profits of the Louisville Gas & Electric Co., the company through its board of directors has authorized the sale to the public of $2,000,000 of preferred stock. The stock will have full voting power and the money thus raised will be used only for retirement of bonds and for additions and extensions.

J. W. Smiley is in charge of the sales, which will be made on the partial payment plan. There is no preferred stock outstanding at present as in the past the

company has financed such improvements by bond issues. The object of the company, according to its announcement, is to make the largest possible number of householders, stockholders of the company and at the same time retain responsible and experienced management.

Business Increase of Pacific Gas & Electric.

Gross earnings of Pacific Gas & Electric increased from $8,947,162 for the year 1906 to $25,498,400 for the year ended Aug. 31, 1919. During the month of September no fewer than 4830 customers were added to the company's distribution lines, bringing the total number of customers served at Sept. 30, 1919, up to 500,994. This is exclusive of the 10,565 customers of the Northern California Power Co., Consolidated, who will be added to the line as an incident of the recent acquisition of the properties of that company.

The rapid growth of business in the Bay region is shown by the fact that the net gain in consumers during September was 1798 in the San Francisco district and 1471 in the Alameda County district.

An estimate of the use of gas in the shipyards of the Pacific Coast submitted at the convention of the Pacific Coast Gas Association, places the consumption at 78,000,000 cubic feet each month, bringing the producers an average revenue of $41,000. It is also estimated that from gas used in the preparation of various food products the revenues amounted to not less than 53½% of the total output, revenues from sales to the shipbuilding industry not exceeding 10%.

Dividends.

Nebraska Power Co. has declared the regular quarterly dividend of 1¾% on preferred stock, payable Dec. 1 to stock of record Nov. 20.

The regular quarterly dividend of 1¾% has been declared on preferred stock by the Colorado Power Co., payable Dec. 15 to stock of record Nov. 29. The regular quarterly dividend of ½ of 1% has also been declared on common stock, payable Jan. 15 to stock of record Dec. 31.

Southwestern Power & Light Co. has declared a quarterly dividend of 1¾% on preferred stock, payable Dec. 1 to stockholders of record Nov. 22.

A quarterly dividend of 1½% on preferred stock has been declared by the Northern Ohio Electric Co., payable Dec. 1 to stockholders of record Nov. 18.

Ohio Cities Gas Co. has declared a cash dividend of $1 per share, payable Dec. 1 to stock of record Nov. 29.

The Philadelphia Electric Co. has declared a quarterly dividend of 1¾%, payable Dec. 15 to stock of record Nov. 20.

Earnings.

NORTHERN STATES POWER CO.

Gross and net earnings of Northern States Power Co. of Delaware and subsidiaries for the month of September, 1919, and year ended Sept. 30, 1919, compared with corresponding previous periods, are reported as follows:

September:	1919.	1918.
Gross	$ 769,620	$ 656,774
Net	276,539	245,906
12 mos. ended Sept. 30:		
Gross	9,477,907	7,943,132
Net	4,053,820	3,286,316

WESTERN STATES GAS & ELECTRIC.

Comparative earnings of the Western States Gas & Electric Co. of Delaware and subsidiaries for the month of September and year ended Sept. 30, 1919, are reported as follows:

September:	1919.	1918.
Gross	$ 156,277	$ 131,749
Net	57,459	39,054
12 mos. ended Sept. 30:		
Gros	1,812,940	1,575,312
Net	750,775	624,945

KEYSTONE TELEPHONE CO.

(Combined earnings.)

	1919.	1918.
October gross	$ 142,548	$ 128,668
Net after taxes	44,789	49,731
Surplus after charges	15,338	21,175
10 months' gross	1,350,880	1,327,561
Net after taxes	442,129	544,758
Surplus after charges	148,678	257,891

CUMBERLAND CO. POWER & LIGHT.

	1919.	1918.
September gross	$ 250,318	$ 299,726
Net after taxes	95,391	107,643
Surplus after charges	39,780	36,401
12 months' gross	2,836,763	3,176,543
Net after taxes	833,871	950,328
Surplus after charges	113,066	97,044
Deficit after pfd. div.	24,934	40,956

HAVANA ELECTRIC RAILWAY, LIGHT & POWER.

	1919.	1918.
September gross	$ 792,317	$ 714,696
Net after taxes	401,597	391,455
Total income	409,848	406,918
Surplus after charges	263,853	228,464
9 months' gross	6,724,847	6,042,507
Net after taxes	3,402,232	3,277,160
Total income	3,481,842	3,385,117
Surplus after charges	2,119,243	1,914,155

NEBRASKA POWER CO.

This subsidiary of American Power & Light Co. reports earnings as follows:

	1919.	1918.
September gross	$ 200,548	$ 162,247
Net after taxes	67,754	59,143
Surplus after charges	38,617	33,975
12 months' gross	2,250,330	1,831,143
Net after taxes	771,338	689,401
Surplus after charges	503,380	458,180
Bal. after pfd. div.	258,380	213,180

PORTLAND RAILWAY, LIGHT & POWER.

	1919.	1918.
September gross	$ 706,479	$ 672,791
Net after taxes	239,917	196,306
Surplus after charges	50,786	8,173
12 months' gross	8,382,345	7,303,001
Net after taxes	2,803,412	2,658,809
Surplus after charges	536,263	467,428

ALABAMA TRACTION, LIGHT & POWER.

Earnings of Alabama Power Co., operating subsidiary of Alabama Traction, Light & Power Co., Ltd., compare as follows for September and 12 months ended Sept. 30:

	1919.	1918.
September gross	$ 258,552	$ 274,022
Net after taxes	125,690	110,142
12 months' gross	3,099,540	2,751,418
Net after taxes	1,711,054	1,519,219

TENNESSEE RAILWAY, LIGHT & POWER.

(Combined earnings.)

	1919.	1918.
September gross	$ 527,745	$ 557,768
Net after taxes	140,639	187,003
Surplus after charges	420	50,845
12 months' gross	6,345,136	5,808,198
Net after taxes	2,124,770	2,040,581
Surplus after charges	451,104	389,167

Above figures include operations of railway department of Chattanooga Railway & Light Co., for which receiver was appointed on April 18, 1919.

NASHVILLE RAILWAY, LIGHT & POWER CO.

This subsidiary of Tennessee Railway, Light & Power Co. reports earnings as follows:

	1919.	1918.
September gross	$ 274,181	$ 271,642
Net after taxes	69,125	97,564
Surplus after charges	30,021	57,339
12 months' gross	3,150,791	2,728,503
Net after taxes	802,174	983,493
Surplus after charges	329,200	496,935
Bal. after pfd. div.	204,200	371,935

CHATTANOOGA RAILWAY & LIGHT.

Earnings of this subsidiary of Tennessee Railway, Light & Power Co. compare as follows for September and 12 months ended Sept. 30. Earnings for the railway department, for which receiver was appointed on April 18, 1919, are included:

	1919.	1918.
September gross	$ 164,034	$ 173,242
Net after taxes	37,789	43,078
Surplus after charges	5,169	11,119
12 months' gross	1,872,329	1,677,838
Net after taxes	400,961	278,396
Surplus after charges	138,422	*50,684
Bal. after pfd. div.	6,734	*95,788

*Deficit.

BANGOR RAILWAY & ELECTRIC.

	1919.	1918.
September gross	$ 97,088	$ 83,952
Net after taxes	45,235	34,500
Surplus after charges	24,083	14,517
12 months' gross	1,018,697	924,778
Net after taxes	368,552	365,491
Surplus after charges	121,762	128,289
Bal. after pfd. div.	16,762	23,289

WEEKLY COMPARISON OF CLOSING-BID PRICES OF SECURITIES OF LEADING ELECTRICAL COMPANIES.

Quotations furnished by F. M. Zeller & Co., Rookery Bldg., Chicago.

Public Utilities.	Div. rate. Per cent.	Bid Nov. 11.	Bid Nov. 18.
Adirondack Electric Power of Glens Falls, common	6	14	14
Adirondack Electric Power of Glens Falls, preferred	6	16	76
American Gas & Electric of New York, common	10+extra	126	125
American Gas & Electric of New York, preferred	6	40	39
American Light & Traction of New York, common	..	210	208
American Light & Traction of New York, preferred	6	93	93
American Power & Light of New York, common	4	54	59
American Power & Light of New York, preferred	6	72	71
American Public Utilities of Grand Rapids, common	..	8	8
American Public Utilities of Grand Rapids, preferred	7	25	23
American Telephone & Telegraph of New York	..	98⅝	100
American Water Works & Elec. of New York, common	..	5¼	5
American Water Works & Elec. of New York, particip	7	10	9
American Water Works & Elec. of New York, first preferred	..	53	50
Appalachian Power, common	..	4	4
Appalachian Power, preferred	7	20½	22
Cities Service of New York, common	+extra	455	437
Cities Service of New York, preferred	6	77½	76
Commonwealth Edison of Chicago	8	111	110¾
Comm. Power, Railway & Light of Jackson, common	..	23	23
Comm. Power, Railway & Light of Jackson, preferred	6	48	46
Federal Light & Traction of New York, common	..	9	7
Federal Light & Traction of New York, preferred	..	44	43
Illinois Northern Utilities of Dixon	6	..	..
Middle West Utilities of Chicago, common	2+extra	25	25
Middle West Utilities of Chicago, preferred	6	52	50
Northern States Power of Chicago, common	..	64	64
Northern States Power of Chicago, preferred	ex.div.7	90	90
Pacific Gas & Electric of San Francisco, common	..	62½	61
Pacific Gas & Electric of San Francisco, preferred	6	..	..
Public Service of Northern Illinois, Chicago, common	7	80	80
Public Service of Northern Illinois, Chicago, preferred	6	85	85
Republic Railway & Light of Youngstown, common	4	14	14
Republic Railway & Light of Youngstown, preferred	6	49	50
Standard Gas & Electric of Chicago, common	..	30½	30
Standard Gas & Electric of Chicago, preferred	6	41½	42
Tennessee Railway, Light & Power of Chattanooga, common	..	4	3
Tennessee Railway, Light & Power of Chattanooga, preferred	6	10	7
United Light & Railways of Grand Rapids, common	4	40	43
United Light & Railways of Grand Rapids, preferred	6	71	70
Western Power of San Francisco, common	..	22	21½
Western Union Telegraph of New York	extra	86	87¼
Industries.			
Electric Storage of Philadelphia, common	4	141	135
General Electric of Schenectady	8	170¼	171½
Westinghouse Electric & Mfg. of Pittsburgh, common	7	55	54¾
Westinghouse Electric & Mfg. of Pittsburgh, preferred	7	..	..